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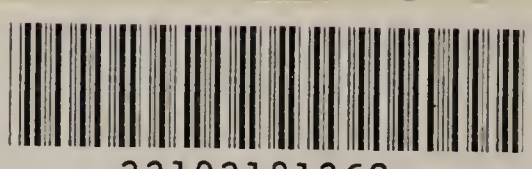
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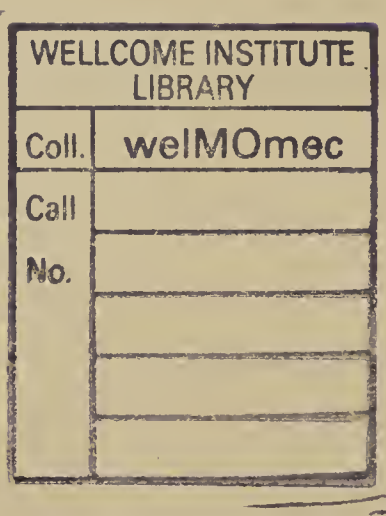

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INDEX NUMBER,

CONTAINING

TITLE-PAGE, INDEX, &c., TO VOLUME XLV.

CONTENTS.

ARTICLES:— PAGE

On a New and Expeditious Method for the Determination of the Nitrites under Different Circumstances, by Edmund W. Davy, A.M., M.D., M.R.I.A. 1

Separation of Gallium, by M. Lecoq de Boisbaudran 3

A New Method of Determining Phosphoric Acid, by Henry Pemberton, Jr. 4

Rules and Regulations Recommended for the Prevention of Fire Risks from Electric Lighting 7

Note on Filtering Discs, by P. Casamajor 8

Note on a New Catalytic Reaction, by George Watson, Jun., F.C.S. 9

NOTICES OF BOOKS.—The Manual of Colours and Dye-Wares: their Properties, Applications, Valuation, Impurities, and Sophistications. For the Use of Dyers, Printers, Drysalters, Brokers, &c. 9

CHEMICAL NOTICES FROM FOREIGN SOURCES 10

MISCELLANEOUS.—A Warning—University College, Bristol 13

NOTES AND QUERIES.—Magnesia-Alum 13

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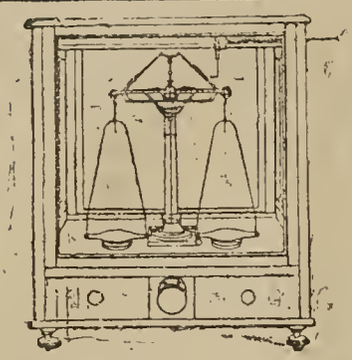

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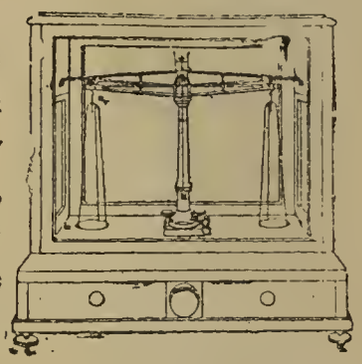

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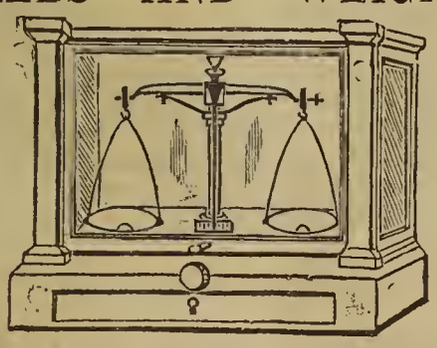

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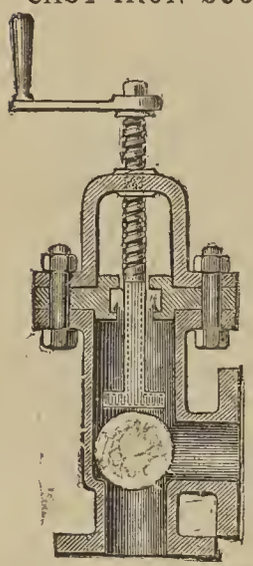

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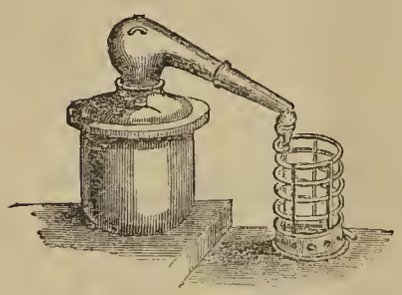

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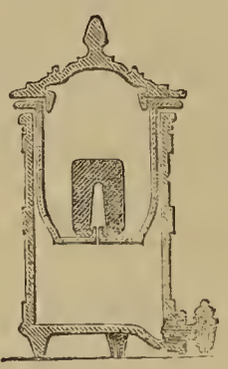

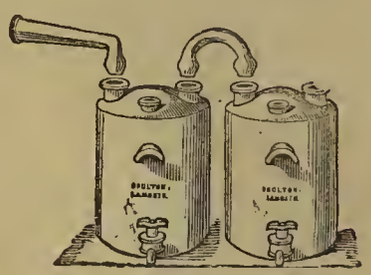

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CONTENTS.

ARTICLES:— PAGE

Revision of the Atomic Weight of Aluminum, by J. W. Mallet, F.R.S. 15
Note on Didymium, by B. Brauner 16
Action of Sulphuretted Hydrogen upon Nickel Sulphate in Acetic Solution, by M. H. Baubigny 17
London Water Supply, by William Crookes, F.R.S., William Odling, M.B., F.R.S., and C. Meymott Tidy, M.B., F.C.S. 17
On the Determination of Reverted Phosphates, by Thomas S. Gladding, A.M. 18
NOTICES OF BOOKS.—The Retrospect of Medicine—Catechism of Modern Elementary Chemistry 21
CORRESPONDENCE.—Sugar Analysis—Flameless Combustion 22
CHEMICAL NOTICES FROM FOREIGN SOURCES 23
MISCELLANEOUS.—Dangerous Device in Shape of a Cigar Lighter 25
NOTES AND QUERIES.—Free Acid 25
TO CORRESPONDENTS 25

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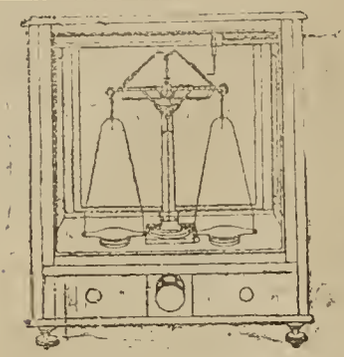

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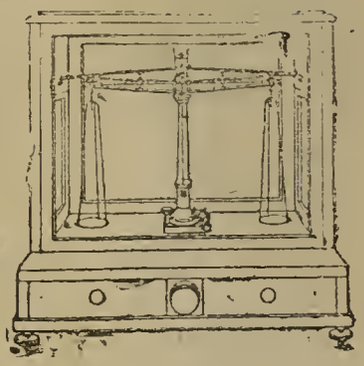

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CONTENTS.

ARTICLES:— PAGE

Revision of the Atomic Weight of Aluminum, by J. W. Mallet, F.R.S. 27
Concerning Phthalimide, by M. Kuhara 30
On the Determination of Reverted Phosphates, by Thomas S. Gladding, A.M. 31
Estimation of Nitric Nitrogen, by J. Boyd Kinnear 33
On the Cause of the Blue Colour of Sapphire, Lazulite, and Lapis Lazuli; the Green of Emerald, and the Purple of Amethyst, by Lieut.-Colonel W. A. Ross, late R.A. 33
CHEMICAL NOTICES FROM FOREIGN SOURCES 34
MISCELLANEOUS.—Royal Institution—Distillation of Coal-tar—A New Isomer of Orcine—Flameless Combustion 36

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THOMAS GRAY,
One of the Assistant Secretaries to the said Board,
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NOTICE.—A meeting will be held in Birmingham early in October, when it is proposed, that the Members, after inspecting some of the works in that industrial centre, should dine together in the evening. Towards the end of September full particulars of the arrangements will be sent to Members.

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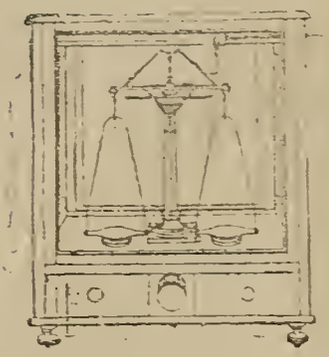

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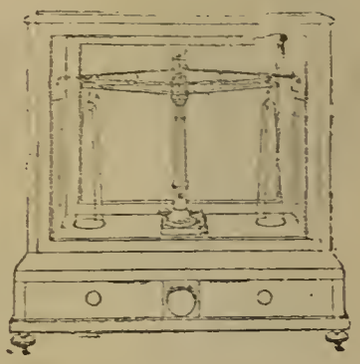

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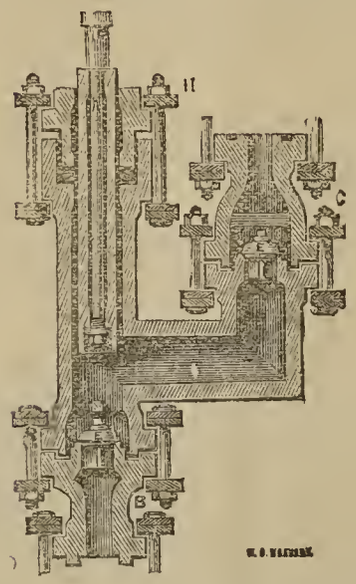

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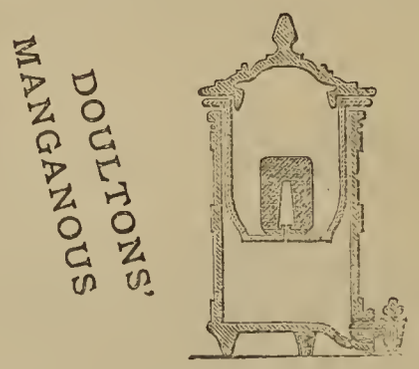

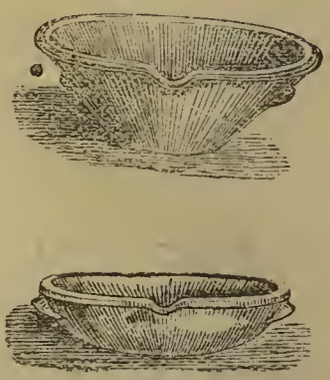

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CONTENTS.

ARTICLES:— PAGE

Apparatus for the Absolute Determination of Nitrogen, by Thomas S. Gladding 39

Sources of Error in Determining Iron in Ores by the Stannous Chloride Method, by K. F. Foehr 40

Action of Sulphuretted Hydrogen upon Nickel Chloride, by M. H. Baubigny 40

Revision of the Atomic Weight of Aluminum, by J. W. Mallet, F.R.S. 41

The Detection of Chloride of Lime in Water, by A. Anthony Nesbit, F.C.S. 43

Remarks on Didymium, by M. P. T. Clève 43

Researches on the Substituted Benzyl Compounds, by C. Loring Jackson and J. Fleming White 44

CORRESPONDENCE.—Sugar Analysis—Determination of Arsenic in Copper—Salt in Beer 45

CHEMICAL NOTICES FROM FOREIGN SOURCES 46

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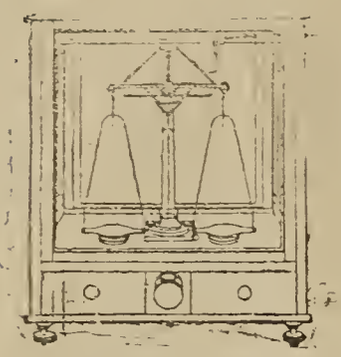

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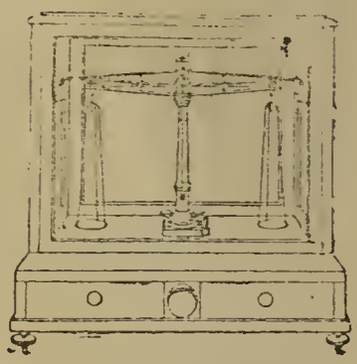

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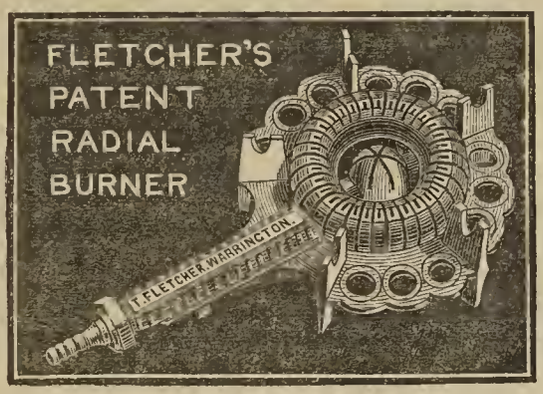

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CONTENTS.

ARTICLES:— PAGE

Electric Lighting by Incandescence, by Joseph W. Swan 49

Analysis of Potash made from Kyathourg Bamboe, by R. Romanis, D.Sc. 51

Researches on the Substituted Benzyl Compounds, by C. Loring Jackson and J. Fleming White 52

Annual Record of Published Scientific Work 55

PROCEEDINGS OF SOCIETIES:—

THE SOCIETY OF CHEMICAL INDUSTRY 56

CHEMICAL NOTICES FROM FOREIGN SOURCES 57

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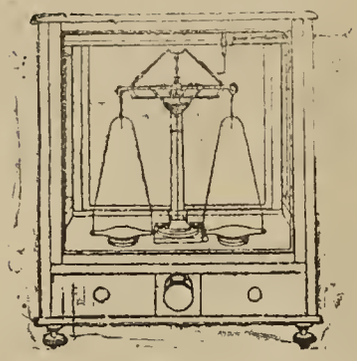

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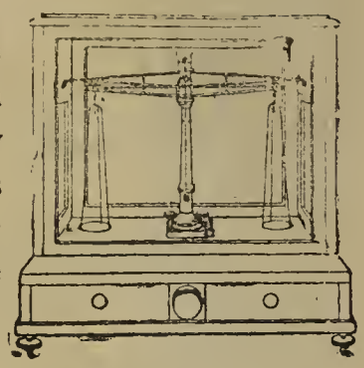

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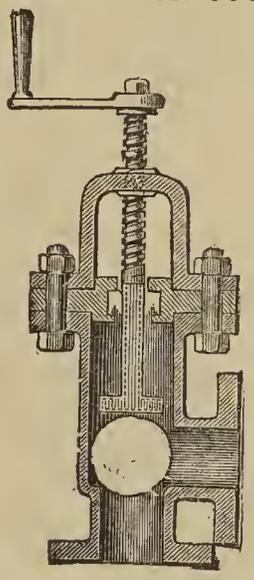

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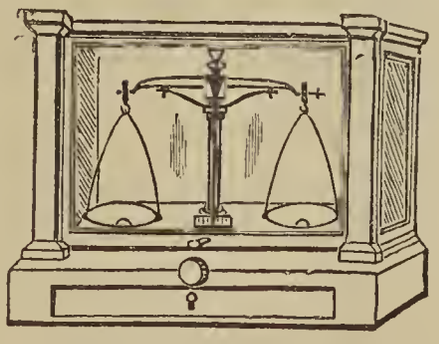

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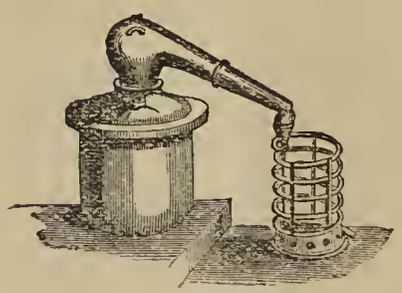

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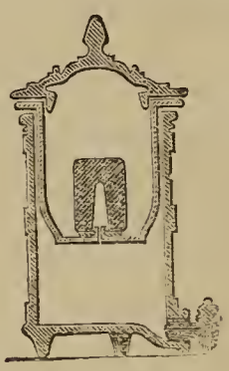

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CONTENTS.

ARTICLES:— PAGE

Electric Lighting by Incandescence, by Joseph W. Swan 59
On Certain Substances Obtained from Turmeric, by C. Loring Jackson and A. E. Menke 61
Action of Aluminium upon Cupric Chloride, by Dr. D. Tommasi.. 62
The Determination of Organic Matter in Potable Water, by Prof. J. W. Mallet, F.R.S..... 63
CHEMICAL NOTICES FROM FOREIGN SOURCES 66
NOTES AND QUERIES.—Extracting Tannin..... 68

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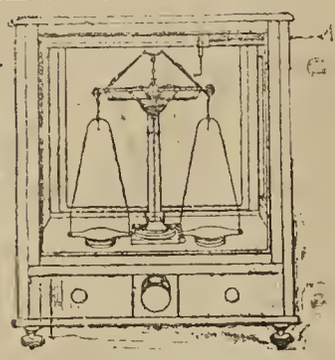

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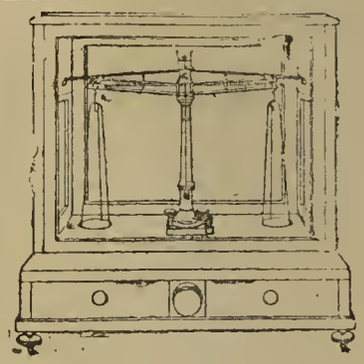

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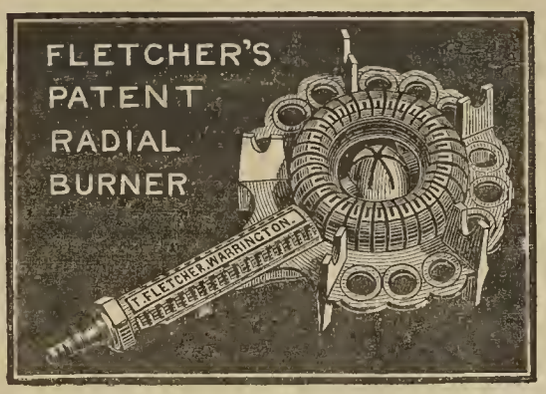

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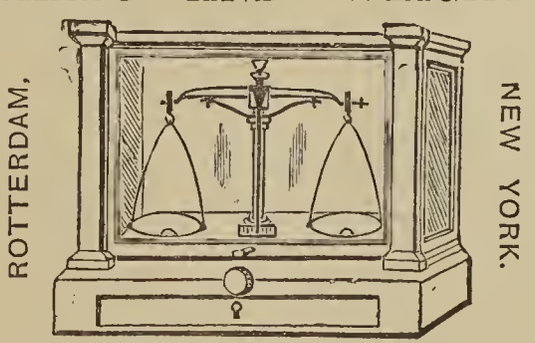

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CONTENTS.

ARTICLES:— PAGE

Separation of Gallium, by M. Lecoq de Boisbaudran 69

On Certain Substances obtained from Turmeric, by C. Loring Jackson and A. E. Menke 70

The Determination of Organic Matter in Potable Water, by Prof. J. W. Mallet, F.R.S. 73

NOTICES OF BOOKS.—Irenicon, No. 2. Faith, the Life-root of Science, Philosophy, Ethics, and Religion—Water Works Statistics; Gas Works Statistics; The Gas and Water Companies' Directory 76

OBITUARY.—Prof. W. Stanley Jevons, F.R.S.—B. J. Grosjean.... 76

CORRESPONDENCE.—Determination of Arsenic in Copper 77

CHEMICAL NOTICES FROM FOREIGN SOURCES 77

CAPPER PASS AND SON, BRISTOL,

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CHARLES E. GROVES, Secretary.

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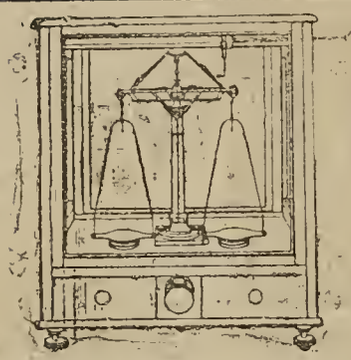

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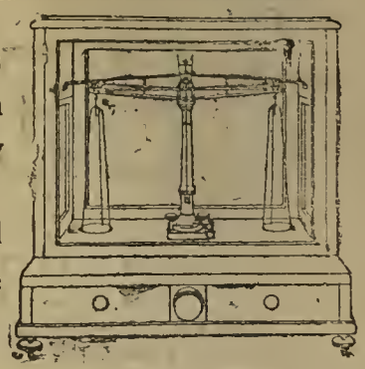

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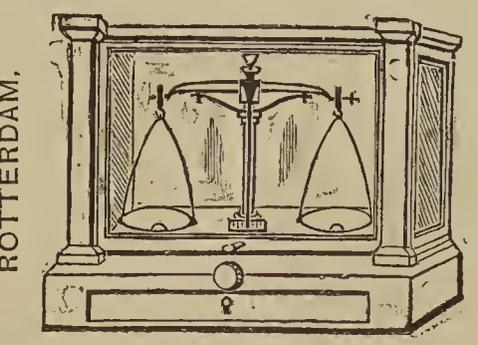

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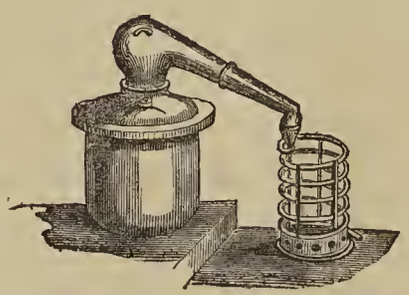

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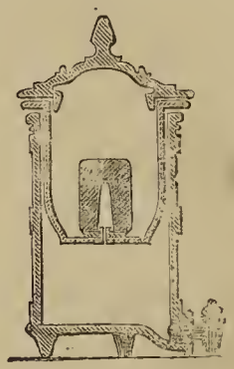

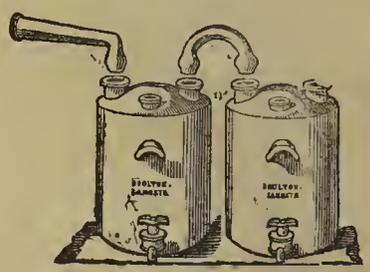

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CONTENTS.

ARTICLES:— PAGE

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE:—

Inaugural Address of the President, C. William Siemens, D.C.L. (Oxon), LL.D. (Glasgow and Dublin), Ph.D., F.R.S., F.C.S., Member Inst. C.E. 79

The Huddersfield Lead-Poisoning Case 88

On a Novel Application of Electrolysis in Dyeing and Printing, by M. F. Goppelsroeder .....

The Determination of Organic Matter in Potable Water, by Prof. J. W. Mallet, F.R.S. 90

CHEMICAL NOTICES FROM FOREIGN SOURCES 92

CAPPER PASS AND SON, BRISTOL,

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LEAD SLAGS, ANTIMONIAL LEAD,
COPPER MATTE, TIN ASHES, &c.,
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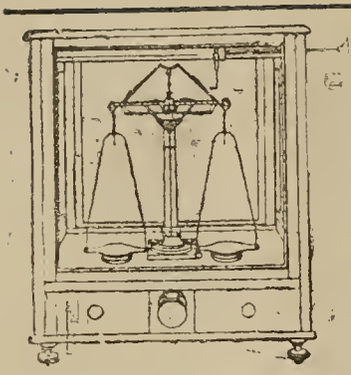

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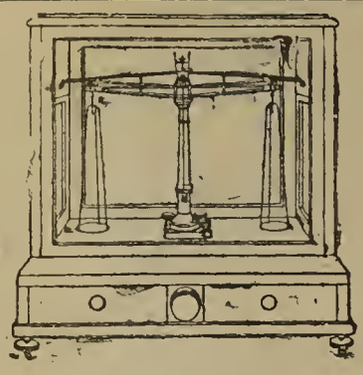

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CONTENTS.

ARTICLES:— PAGE

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE:—
Address to the Mathematical and Physical Science Section, by Right Hon. Lord Rayleigh, M.A., F.R.S., F.R.A.S..... 95
Address to the Chemical Section, by Prof. G. D. Liveing, M.A., F.R.S., F.C.S., President of the Section..... 97
The Determination of Organic Matter in Potable Water, by Prof. J. W. Mallet, F.R.S..... 101
NOTICES OF BOOKS.—Elementary Chemical Arithmetic—The Elements of Machine Design—Handbook of Patent Law of all Countries..... 102
CHEMICAL NOTICES FROM FOREIGN SOURCES..... 103

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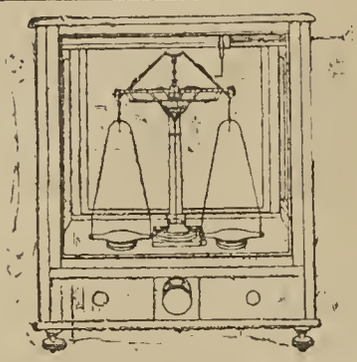

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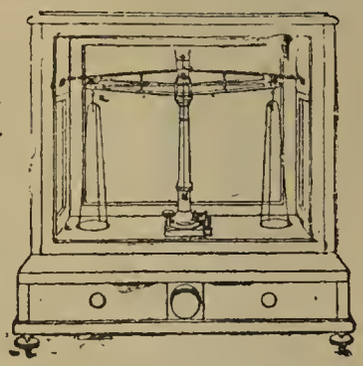

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The SESSION will open on MONDAY, October 2. Students are required before entering to have passed one of the Preliminary Examinations prescribed by the General Medical Council.

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NOTICE IS HEREBY GIVEN, That the said Edward William Parnell and James Simpson, of the city of Liverpool in the county of Lancaster, by assignment as tenants in common of the said Letters Patent, have applied by Petition to the Commissioners of Patents, according to the statute in that case made and provided, for leave to file in the Great Seal Patent Office, a Disclaimer and Memorandum of Alteration of certain parts of the Specification of the said Letters Patent, and that any person intending to oppose such application must leave particulars in writing of their objection to such proposed Disclaimer and Memorandum of Alteration at the office of the Solicitor-General, No. 11, New Court, Carey Street, London, within twenty-one days from the date of the "London Gazette" in which this notice is published.

AND NOTICE IS HEREBY ALSO GIVEN, That after the expiration of the said twenty-one days no objection will be received or entertained, and the Solicitor-General will proceed to a hearing.

Dated this 24th day of August, 1882.

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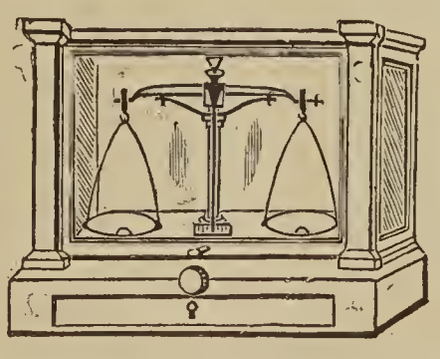

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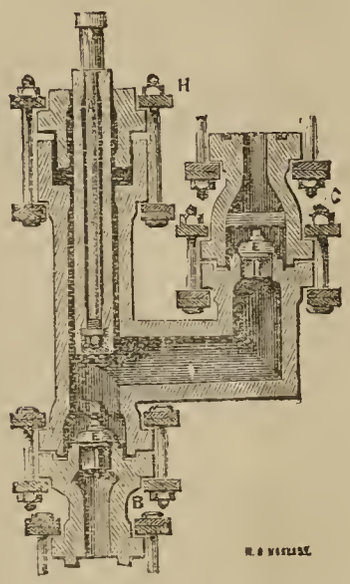

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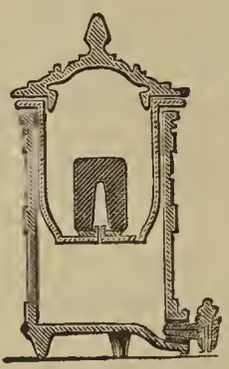

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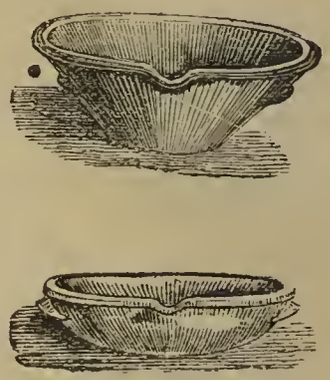

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CONTENTS.

ARTICLES:— PAGE

On the Origin and Formation of the Diamond in Nature, by A. B. Griffiths, F.C.S., &c. ... 105

The Processes of MM. A. Classen and A. von Reiss for the Determinations and Separations of Metals by the Electrolytic Method, Report by V. Francken ... 105

London Water Supply, by William Crookes, F.R.S., William Odling, M.B., F.R.S., and C. Meymott Tidy, M.B., F.C.S ... 107

The Determination of Organic Matter in Potable Water, by Prof. J. W. Mallet, F.R.S. ... 108

NOTICES OF BOOKS.—Light—The Student's Guide in Quantitative Analysis ... 112

CORRESPONDENCE.—Chemistry and Courtesy in Germany—Sugar Analysis ... 112

CHEMICAL NOTICES FROM FOREIGN SOURCES ... 113

MISCELLANEOUS ... 114

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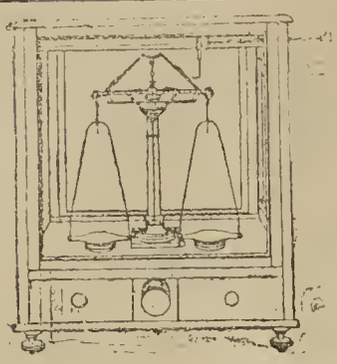

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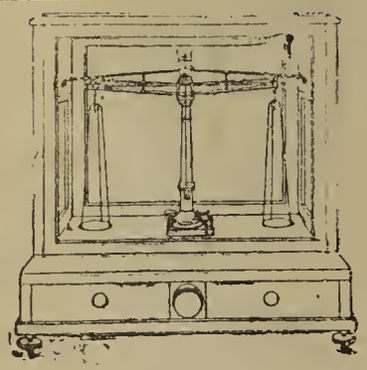

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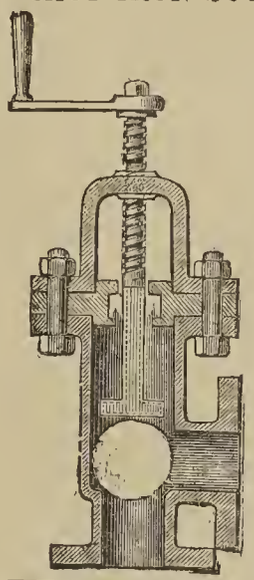

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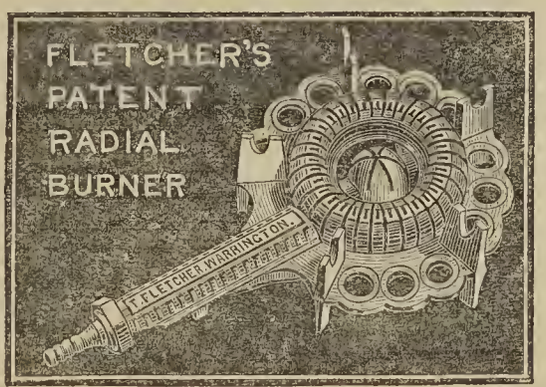

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CONTENTS.

ARTICLES:— PAGE
Chemical Literature, by Prof. H. Carrington Bolton, Ph.D..... 115
Assays of Cinchona..... 117
Calcic Hypochlorite, by C. T. Kingzett, F.I.C., F.C.S..... 120
The Oxidation of Terpenes, by C. T. Kingzett, F.I.C., F.C.S.... 120
Hydrocarbons of Formula $(C_5H_8)n$, by W. A. Tilden, D.Sc., F.R.S..... 120
Process of MM. Blas and Miest for the Economic Extraction of the Precious Metals from all kinds of Ores by Electrolysis.... 121
CHEMICAL NOTICES FROM FOREIGN SOURCES..... 122
MISCELLANEOUS..... 124

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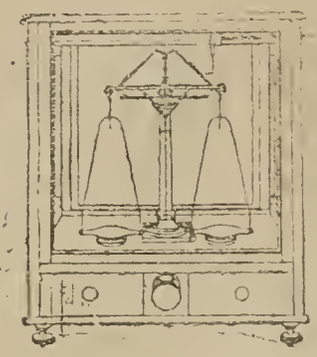

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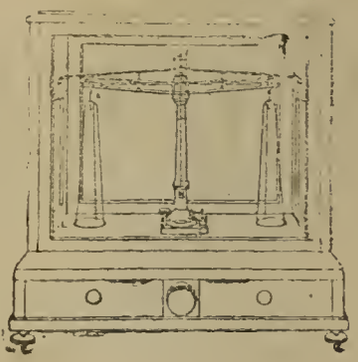

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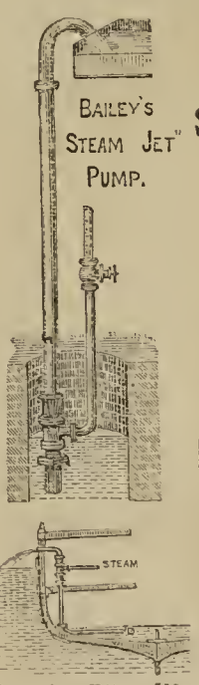

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The SESSION will open on MONDAY, October 2. Students are required before entering to have passed one of the Preliminary Examinations prescribed by the General Medical Council.

4. EVENING CLASSES.

The SESSION will open on MONDAY, October 9. New Students will be admitted on WEDNESDAY, THURSDAY, and FRIDAY preceding, between half-past 6 o'clock and 9 o'clock P.M.

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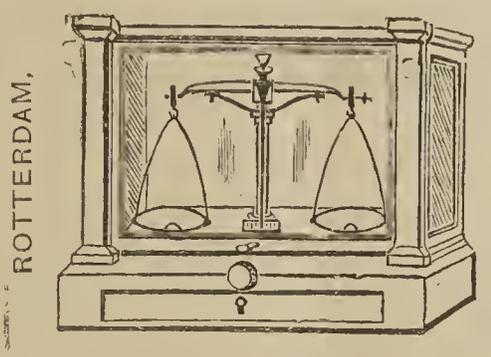

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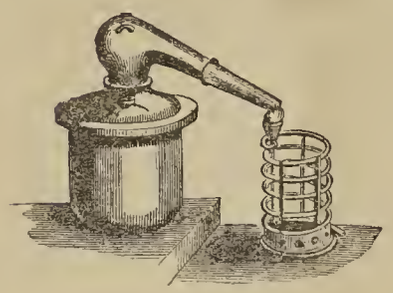

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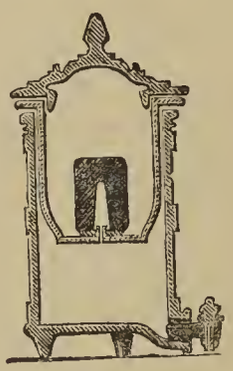

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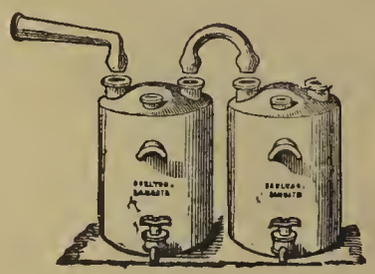

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STUDENTS' NUMBER.

CONTENTS.

ARTICLES:— PAGE

Address to Students 125

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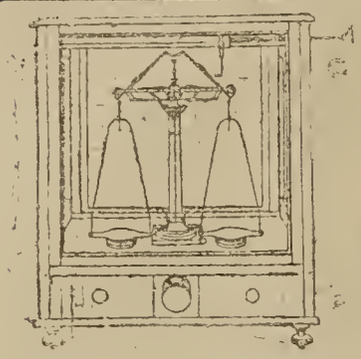

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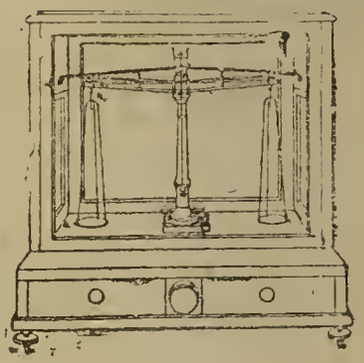

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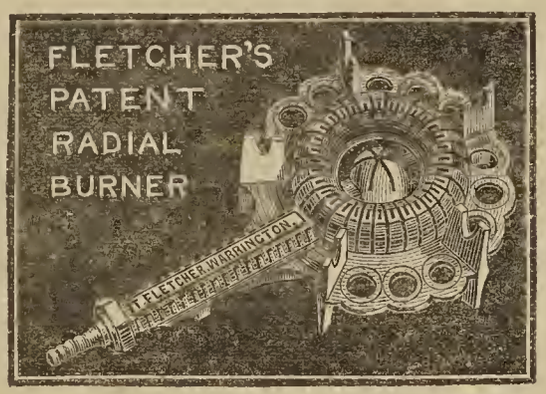

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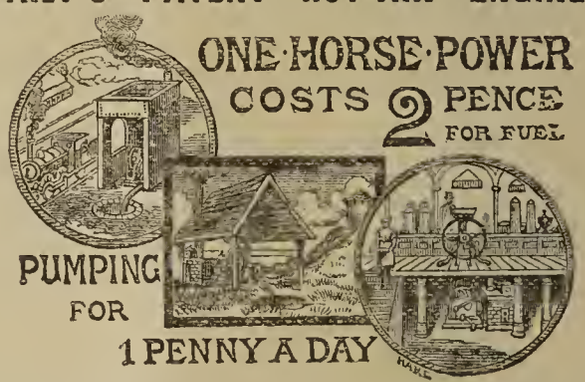

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CONTENTS.

ARTICLES:— PAGE

On the Activity of Oxygen and the Mode of Formation of Hydrogen Dioxide, by C. T. Kingzett, F.I.C., F.C.S. 141
Report of the Committee on the Calibration of Mercurial Thermometers 142
The Action of Water on Lead, by Alfred H. Allen..... 145
Chemical Literature, by Prof. H. Carrington Bolton, Ph.D..... 146
Schools of Chemistry, &c..... 146
CORRESPONDENCE.—Calcic Hypochlorite—Commercial Analyses—Chemistry in Germany—A New Process for Insulating Electric Wires 148
CHEMICAL NOTICES FROM FOREIGN SOURCES..... 149
MISCELLANEOUS..... 150
NOTES AND QUERIES..... 150

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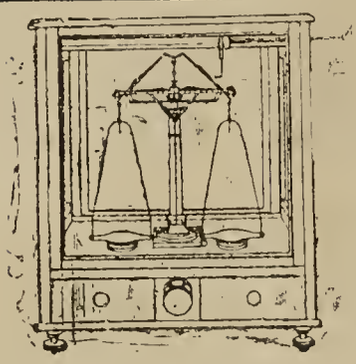

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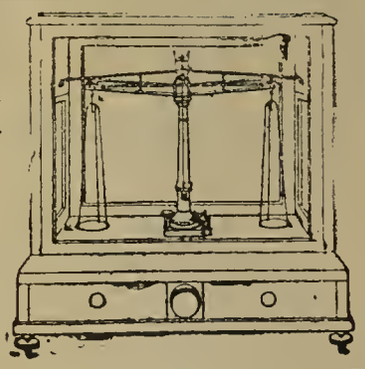

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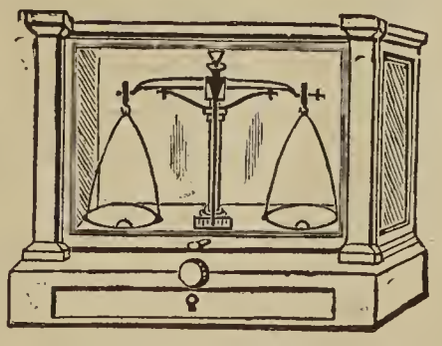

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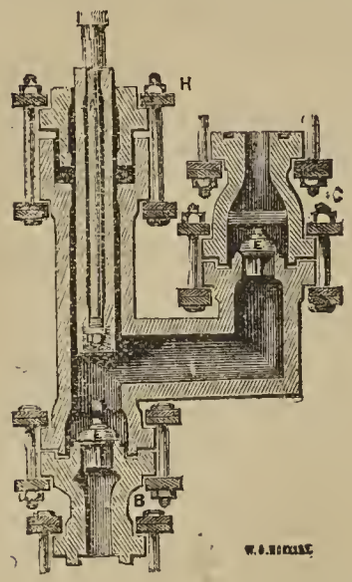

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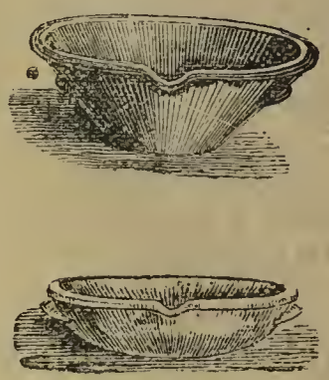

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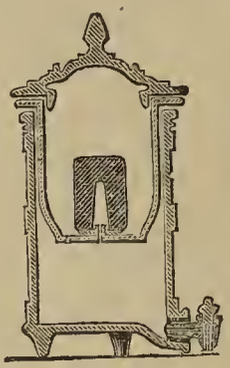

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CONTENTS.

ARTICLES:— PAGE

The Influence of Aqueous Vapour on the Explosion of Carbonic Oxide and Oxygen, by Harold B Dixon, M.A..... 151

The Velocity of Explosion of a Mixture of Carbonic Oxide and Oxygen with Varying Quantities of Aqueous Vapour, by Harold B. Dixon, M.A..... 151

Separation of Gallium, by M. Lecoq de Boisbaudran..... 152

London Water Supply, by William Crookes, F.R.S., William Odling, M.B., F.R.S., and C. Meymott Tidy, M.B., F.K.S..... 153

Chemical Literature, by Prof. H. Carrington Bolton, Ph.D..... 153

NOTICES OF BOOKS.—The Concepts and Theories of Modern Physics—A Treatise on the Distillation of Coal-Tar and Ammoniacal Liquor and the Separation from them of Valuable Products..... 156

CHEMICAL NOTICES FROM FOREIGN SOURCES..... 159

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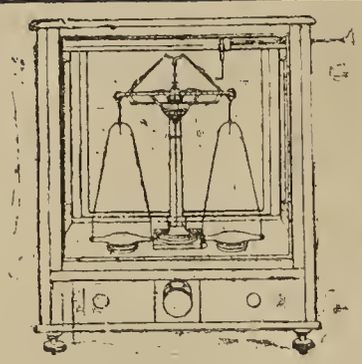

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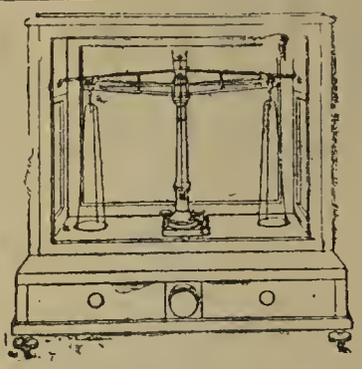

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CONTENTS.

ARTICLES:— PAGE
On the Electric Furnace, by C. W. Siemens, D.C.L , F.R.S., and A. K. Huntington, Professor of Metal urgy..... 163
Rattlesnake Poison, by Henry H. Croft..... 165
Separation of Gallium, by M. Lecoq de Boisbaudran..... 165
Chemical Literature, by Prof. H. Carrington Bolton, Ph.D..... 166
The American Association for the Advancement of Science, by a Foreign Visitor..... 167
NOTICES OF BOOKS.—On Artificial Manures..... 168
CORRESPONDENCE.—The Action of Water on Lead—Importing Atmospheric Air—Formation of Ozone 170
CHEMICAL NOTICES FROM FOREIGN SOURCES..... 171
MISCELLANEOUS..... 173

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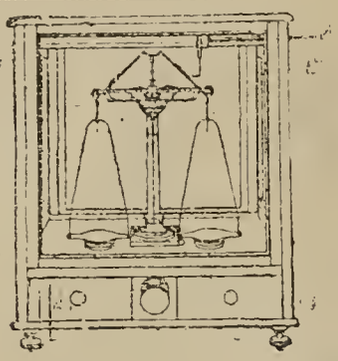

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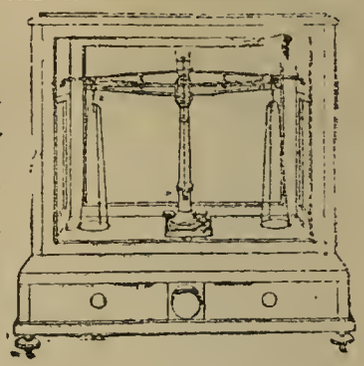

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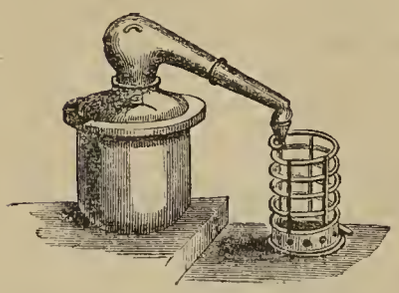

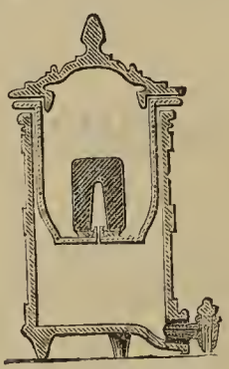

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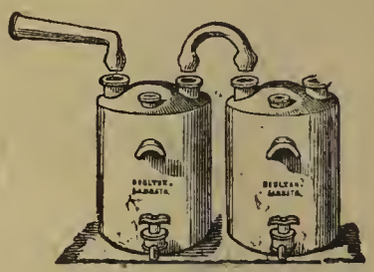

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CONTENTS.

ARTICLES:— PAGE

The Estimation of Dextrose, Maltose, and Dextrine in Amylose (Starch Sugar), by Harvey W. Wiley 175
The Reactions of the Mexican Amalgamation Process 177
On the Properties of Pure Metallic Aluminum, by J. W. Mallet .. 178
On the Fixation of certain Artificial Colouring-Matters by Means of Metallic Mordants, by M. Horace Kœchlin 179
Pyrological Notes, by Lieut-Colonel W. A. Ross, late R.A 179
Influence of Peptones and certain Inorganic Salts on the Diastatic Action of Saliva, by R. H. Chittenden and J. S. Ely 180
NOTICES OF BOOKS.—Journal and Proceedings of the Royal Society of New South Wales, 1881 182
OBITUARY.—The late Professor Wœhler 183
CORRESPONDENCE.—Secondary Battery—A Warning—Formation of Ozone 183
CHEMICAL NOTICES FROM FOREIGN SOURCES 184

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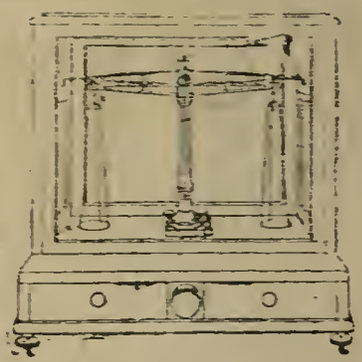

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CONTENTS.

ARTICLES:— PAGE
Analyses of Indian Wood, by W. R. Criper, F.I.C., &c. 187
Laboratory Notes, by R. Romanis..... 187
Japanese Soils—A Natural Cement, by Dr. O. Korschelt..... 187
Influence of Peptones and certain Inorganic Salts on the Diastatic Action of Saliva, by R. H. Chittenden and J. S. Ely..... 189
London Water Supply, by William Crookes, F.R.S., William Odling, M.B., F.R.S., and C. Meymott Tidy, M.B., F.R.S 191
The Patent Vacuum-Pump Refrigerator and Ice-Machine..... 192
Notes of Work by Students of Practical Chemistry in the Laboratory of the University of Virginia, No. XI., communicated by J. W. Mallet..... 194
CORRESPONDENCE.—Safety Cheques..... 196
CHEMICAL NOTICES FROM FOREIGN SOURCES..... 196
MISCELLANEOUS..... 197
NOTES AND QUERIES..... 197
MEETINGS FOR THE WEEK..... 197

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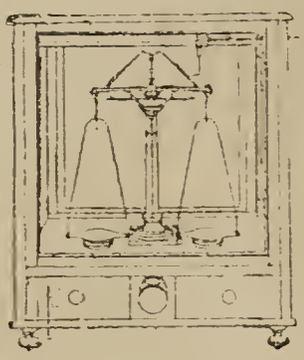

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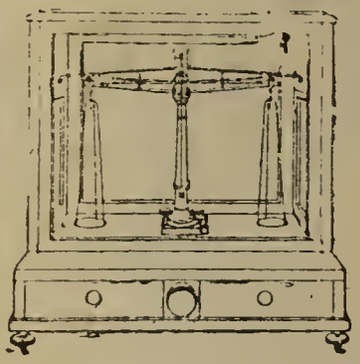

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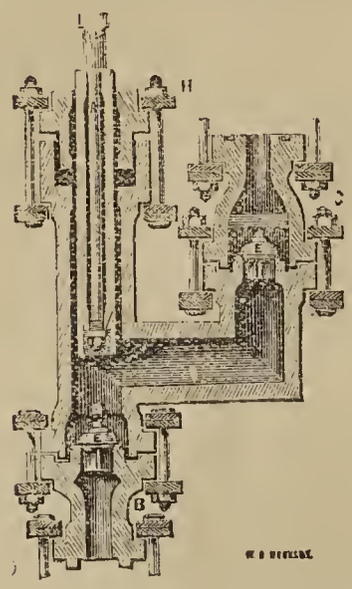

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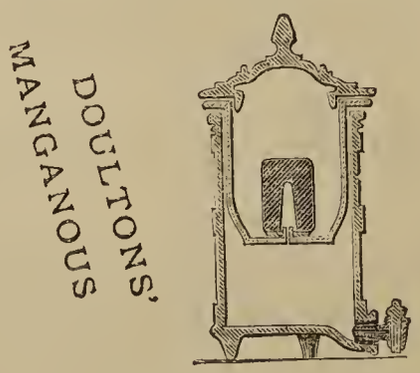

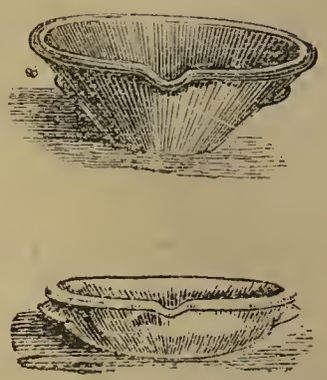

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CONTENTS.

ARTICLES:— PAGE

Estimation of Sulphur in Iron and Steel, by George Craig..... 199
On the Colouring-Matter (Ruberine) and the Alkaloid (Agarythrine) contained in *Agaricus ruber*, by Dr. T. L. Phipson, F.C.S., &c..... 199
Pyrological Notes, by Lieut-Colonel W. A. Ross, late R.A..... 200
The New Analysis of the Buxton Thermal Water, by J. C. Thresh, D.Sc..... 201
Notes of Work by Students of Practical Chemistry in the Laboratory of the University of Virginia, No. XI., communicated by J. W. Mallet..... 204
NOTICES OF BOOKS.—Chemiker-Kalender, 1883—Address in Surgery—Tokio Daigaku..... 206
CORRESPONDENCE.—Electricity and Comets—A Warning..... 207
CHEMICAL NOTICES FROM FOREIGN SOURCES..... 207
MEETINGS FOR THE WEEK..... 209
TO CORRESPONDENTS..... 209

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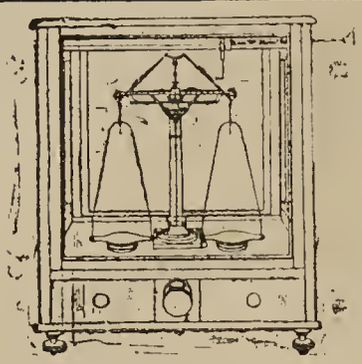

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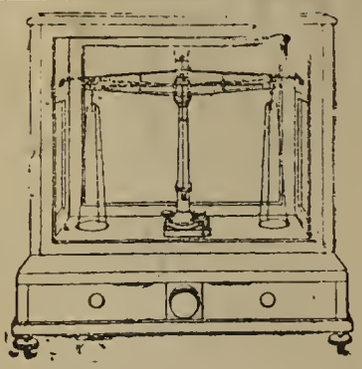

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CONTENTS.

ARTICLES:— PAGE

Separation of Gallium, by M. Lecoq de Boisbaudran 211

New Method of Detecting Dyes on Yarns and Tissues, by Jules Joffre 211

Determination of Potassa in Manures, by M. E. Dreyfus 212

On the Estimation of Phosphoric Acid as Magnesic Pyrophosphate, by Thomas S. Gladding, A.M 213

Notes of Work by Students of Practical Chemistry in the Laboratory of the University of Virginia, No. XI., communicated by J. W. Mallet 215

On Sauer's Method of Estimating Sulphur, and some Modifications, by W. G. Mixter 217

PROCEEDINGS OF SOCIETIES:—

CHEMICAL SOCIETY.—On Dihydroxy-benzoic Acids and Iodosalicylic Acids—Crystalline Molecular Compounds of Naphthalene and Benzene with Antimony Chloride—Additional Evidence that Quinoline belongs to the Aromatic Series of Organic Substances—Orcin and some of the other Di-oxytoluols—Varying Quantities of Malt Albumenoids Extracted by Waters of Different Types—Derivatives of Ethylene Chlorobromide 219

CORRESPONDENCE.—An Examination Question 220

CHEMICAL NOTICES FROM FOREIGN SOURCES 220

MEETINGS FOR THE WEEK 221

NOTES AND QUERIES 221

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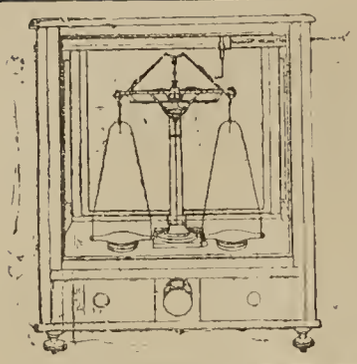

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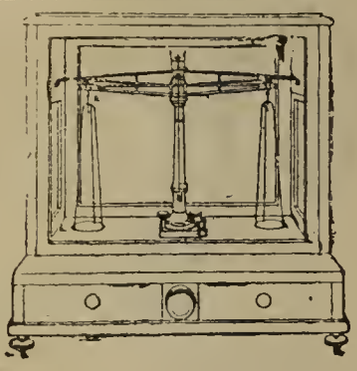

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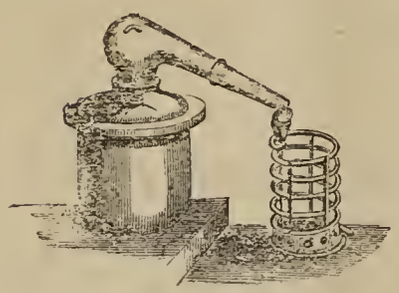

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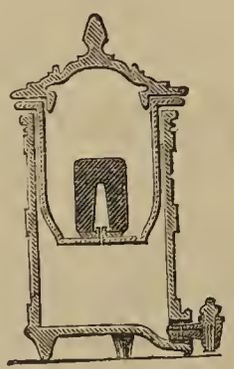

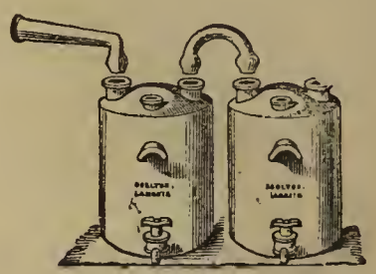

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CONTENTS.

ARTICLES:— PAGE
Testing for Barium or Sulphuric Acid, by Spencer Pickering, B.A. (Oxon) 223
Pyrological Notes, by Lieut-Colonel W. A. Ross, late R.A..... 223
The Absorption of Metallic Oxides by Plants, by Francis C. Phillips 224
The Orchard Alum Spring, by Dr. Thresh..... 226
Notes on Water Analysis, by Reuben Haines..... 227
PROCEEDINGS OF SOCIETIES:—
PHYSICAL SOCIETY.—New Concave Gratings for giving a Diffraction-spectrum—Conservation of Energy and Central Forces—Historical Notes on Physics—Reis's Telephone..... 230
ROYAL INSTITUTION OF GREAT BRITAIN..... 230
NOTICES OF BOOKS.—The Magneto-electric and Dynamo-electric Machines—Arithmetical Chemistry—The Yorkshire College, Leeds—Synopsis of Chemistry, Inorganic and Organic..... 230
CHEMICAL NOTICES FROM FOREIGN SOURCES..... 232
MEETINGS FOR THE WEEK..... 233
NOTES AND QUERIES..... 233

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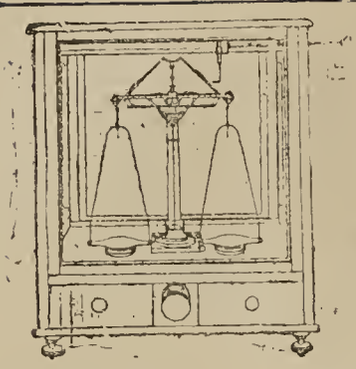

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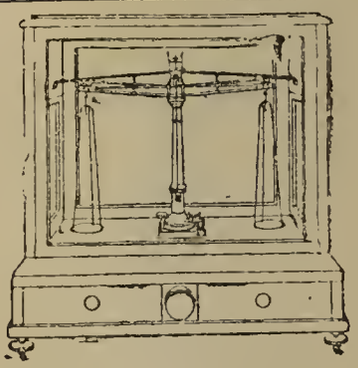

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CONTENTS.

ARTICLES:— PAGE
On a New Method of Making a Volumetric Solution for Determining the Hardness of Water, by C. R. C. Tichborne, LL.D., F.I.C., Analyst to County Longford, &c. 235
Estimation of Sulphur in Pig-iron, by H. Rocholl 236
London Water Supply, by William Crookes, F.R.S., William Odling, M.B., F.R.S., and C. Meymott Tidy, M.B., F.K.S 236
Notes on Water Analysis, by Reuben Haines 237
PROCEEDINGS OF SOCIETIES:—
CHEMICAL SOCIETY.—Contributions to the Chemistry of Tartaric and Citric Acids—Contributions to the Chemistry of Bass Fibres—Oxidation of Cellulose—Analysis of certain Vegetable Fibres—Constitution of some Bromine Derivatives of Naphthalene—Constitution of Lophin 239
METEOROLOGICAL SOCIETY 241
NOTICES OF BOOKS 242
CORRESPONDENCE.—Test for Urea 242
CHEMICAL NOTICES FROM FOREIGN SOURCES 242
MISCELLANEOUS 245
MEETINGS FOR THE WEEK 245
NOTES AND QUERIES 245

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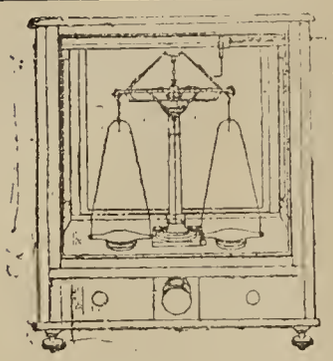

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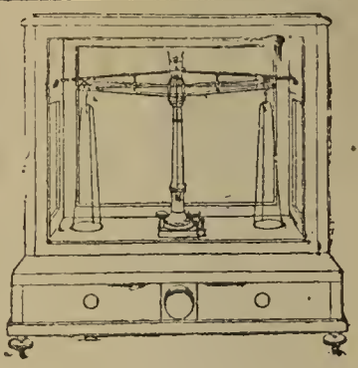

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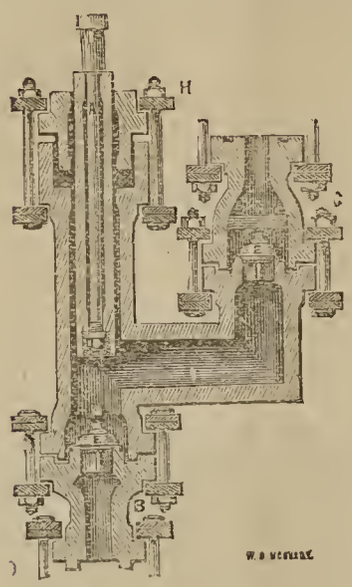

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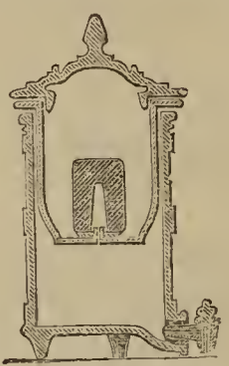

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CONTENTS.

ARTICLES:— PAGE
On a New Form of Apparatus for Estimating Ammonia in Potable Waters, by C. R. Tichborne, LL.D., F.C.S., &c..... 247
Analyses of Tobacco Ash, by R. Romanis..... 248
Pyrological Notes, by Lieut-Colonel W. A. Ross, late R.A..... 248
Researches on Rubidium and Cæsium, by M. C. Setterberg..... 249
On the Metals of Cerite, by M. B. Brauner..... 249
New Method of Detecting Dyes on Yarns and Tissues, by Jules Joffre..... 250
PROCEEDINGS OF SOCIETIES:—
PHYSICAL SOCIETY.—Rainbows produced by Light Reflected before entering the Raindrops—General Method of Strengthening Telephonic Currents..... 251
NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.—Committee's Report—Inaugural Address of the President..... 251
CHEMICAL NOTICES FROM FOREIGN SOURCES..... 254
MEETINGS FOR THE WEEK..... 257
NOTES AND QUERIES..... 257

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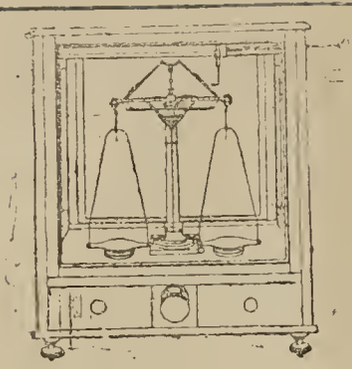

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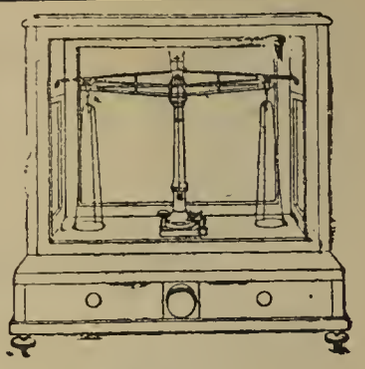

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CONTENTS.

ARTICLES:— PAGE
On the Leclanché Cell, and the Reactions of Manganese Oxides with Ammonium Chloride, by Edward Divers, M.D. 259
On some Analyses of a Recently-discovered Deposit of Guano in Australia, by A. B. Griffiths, F.C.S. 260
New Method of Detecting Dyes on Yarns and Tissues, by Jules Joffre 260
PROCEEDINGS OF SOCIETIES:—
THE ROYAL SOCIETY 261
NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.—Inaugural Address of the President 261
NOTICES OF BOOKS.—Manual of Blowpipe Analysis—Magnetism—Notes on Chemical Calculations, with Examples—Pennsylvania Pharmaceutical Association 265
CORRESPONDENCE.—Water Analysis—A Correction 266
CHEMICAL NOTICES FROM FOREIGN SOURCES 267
MEETINGS FOR THE WEEK 269
NOTES AND QUERIES 269

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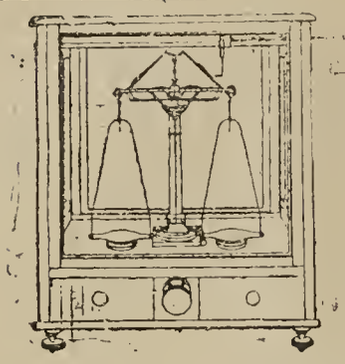

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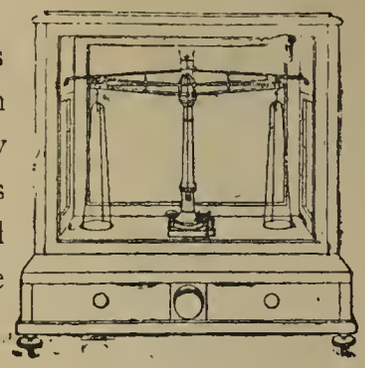

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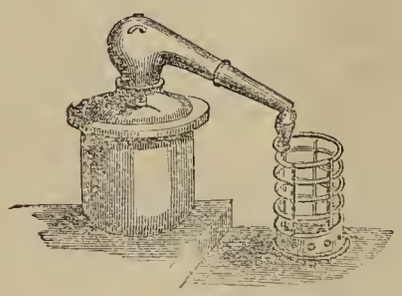

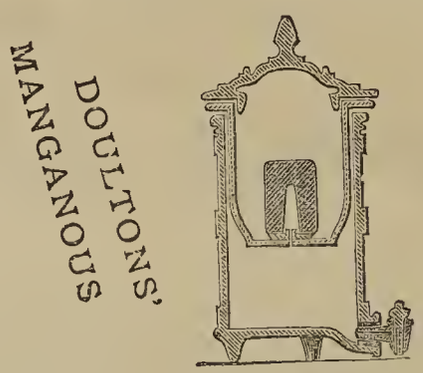

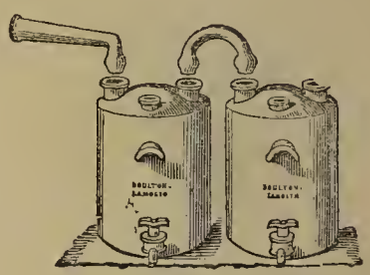

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CONTENTS.

ARTICLES:— PAGE

On the Comparative Effects of Two Metameric Bodies on the Growth of *Nicotiana Longiflora*, by J. Emerson Reynolds, M.D., F.R.S. 271

Estimation of Sulphur in Iron and Steel, by George Craig 272

Pyrological Notes, by Lieut-Colonel W. A. Ross, late R.A. 273

PROCEEDINGS OF SOCIETIES:—

CHEMICAL SOCIETY.—Condensation-Products of Œnanthol—Condensation-Products of Isobutyl-aldehyd—Condensation-Product of Phenanthraquinone with Ethylic Aceto-acetate—Constitution of Lophin—Constitution of Molecular Compounds—Chemistry of Hay and Ensilage—Brominated Carbon Compounds obtained in the Manufacture of Bromine—Preparation of Diphenylene-ketone Ether 273

ROYAL INSTITUTION OF GREAT BRITAIN 275

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.—Inaugural Address of the President 275

NOTICES OF BOOKS.—Elementary Lessons in Electricity and Magnetism 278

CORRESPONDENCE.—On the Discovery of the Periodic Law 278

CHEMICAL NOTICES FROM FOREIGN SOURCES 279

MEETINGS FOR THE WEEK 281

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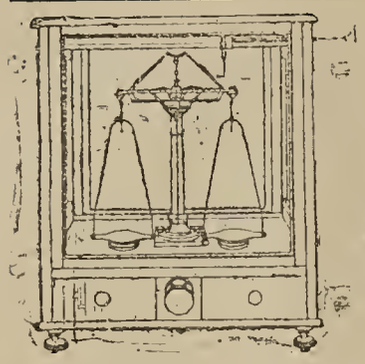

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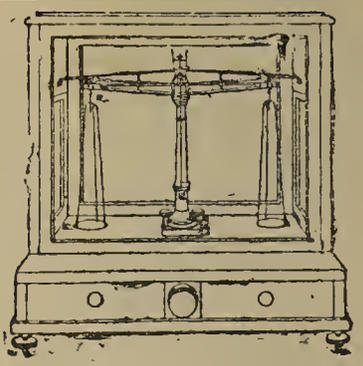

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CONTENTS.

ARTICLES:— PAGE
Rupert's Drops, by I. Taylor, B.A. (Oxon) 283
Pyrological Notes, by Lieut-Colonel W. A. Ross, late R.A. 283
On the Preparation of the Alkaline Potassium Permanganate Solution used for Water Analysis, by Joseph Stapleton 284
Volumetric Determination of Copper, Iron, and Antimony by the Processes of M. F. Weil 284
The Removal of Fixed Glass Stoppers 286
Note on the Precipitation of Stannic Oxide from Sodium Stannate, by Peter T. Austen 286
Determination of Boracic Acid, by Edgar F. Smith 286
On the Reduction of Ferric Solutions, by Peter T. Austen and Geo. B. Hurff 287
PROCEEDINGS OF SOCIETIES:—
PHYSICAL SOCIETY.—Velocity of Light of Different Colours—Resistance of the Voltaic Arc—Relative Intensities of the Magnetic Field 288
MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.—Note on the Development of Living Germs in Water 288
CHEMICAL NOTICES FROM FOREIGN SOURCES 290
MEETINGS FOR THE WEEK 292

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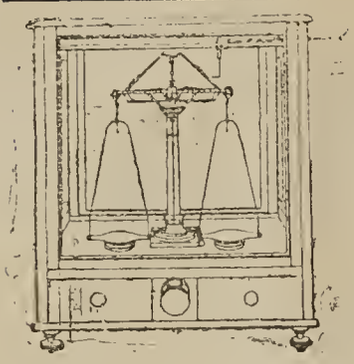

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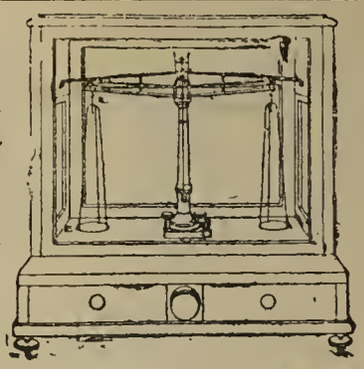

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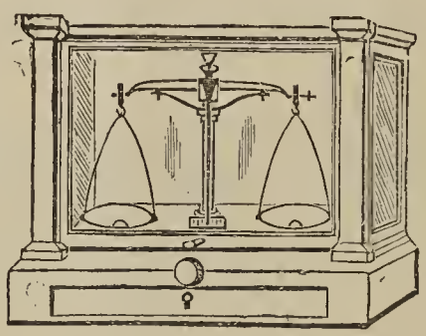

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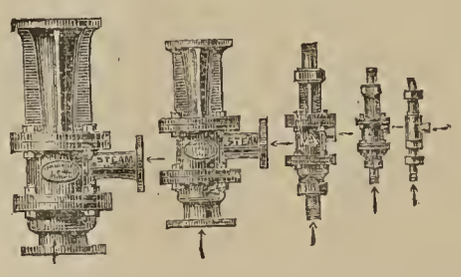

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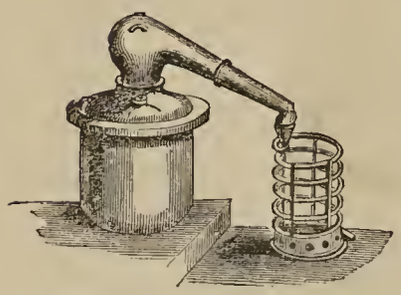

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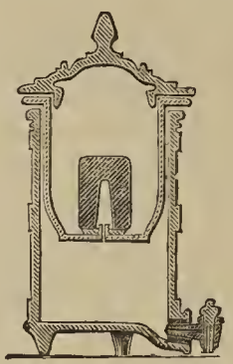

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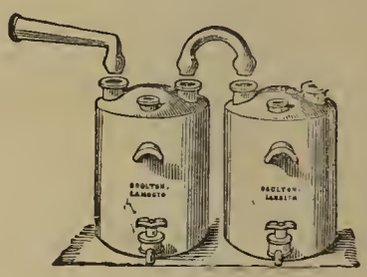

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CONTENTS.

ARTICLES:— PAGE
On the Origin of the Hydrocarbon Flame Spectrum, by G. D. Liveing, M.A., F.R.S., and J. Dewar, M.A., F.R.S. 293
London Water Supply, by William Crookes, F.R.S., William Odling, M.B., F.R.S., and C. Meymott Tidy, M.B., F.K.S 297
On the Determination of the Flashing-Point of Petroleum, by John T. Stoddard 297
Note on a Tube-stand for Nesslerising, by P. T. Austen and F. A. Wilbur 298
PROCEEDINGS OF SOCIETIES:—
CHEMICAL SOCIETY.—Condensation-Products of Œnanthol—Behaviour of the Nitrogen of Coal during Destructive Distillation—Absorption of Weak Reagents by Cotton, Silk, and Wool—The Alkaloids of Nux vomica: No. 2. On Brucine—Preliminary Note on some Diazo-Derivatives of Nitro-benzyl-cyanide—Researches on the Induline Group 299
METEOROLOGICAL SOCIETY.—Popular Weather Prognostics—Report on the Phenological Observations for the Year 1882.... 300
CORRESPONDENCE.—Useful Applications of Electricity 301
CHEMICAL NOTICES FROM FOREIGN SOURCES 302
MEETINGS FOR THE WEEK 303

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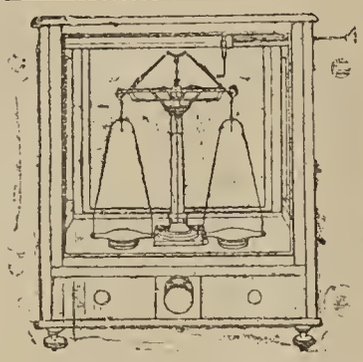

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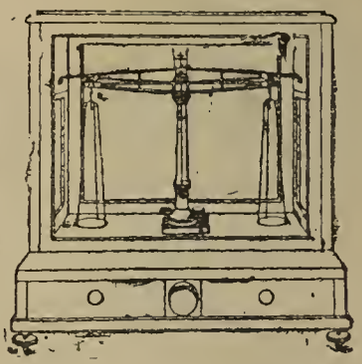

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MEDICINAL do. Cryst. at 35° C.		SULPHO-PHENIC ACID (CRYST.)	NAPHTHALINE.
COMMERCIAL do. No. 1 ,, 35° C.		SULPHO-PHENATES & SULPHO-CRESYLATES OF SODA, POTASH, ZINC, IRON, and ALUMINA.	PICRIC ACID (Cryst. and Paste).
,, do. 2 ,, 29° C.			AURINE (Rosolic Acid Cake and Solution.
,, do. 3 ,, 12° C.			
,, do. 4 liquid at 0° C.			
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ON A NEW AND EXPEDITIOUS METHOD FOR THE DETERMINATION OF THE NITRITES UNDER DIFFERENT CIRCUMSTANCES.*

By EDMUND W. DAVY, A.M., M.D., M.R.I.A.,
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As the existence of nitrites and nitrates in different natural waters has been regarded (under certain circumstances) as affording evidence of previous sewage contamination, the determination of the presence or absence of such compounds, and their quantitative estimation when present, in the waters employed for domestic purposes, may be a matter of much importance in a hygienic point of view; and though we have some delicate tests for the detection in such of the presence both of nitrites and nitrates, as well as different methods for their conjoint quantitative determination, there is no very simple or expeditious method for the separate estimation of nitrites in waters, which may sometimes be required, if we except that not long since proposed by P. Griess, which method I shall presently describe, and compare with the one I have myself devised, and which I shall now lay before the Academy.

In making lately some experiments on certain nitrites, I observed a reaction, which, as far as I am aware, has not hitherto been described; and this being one of extreme delicacy, I have founded on it a new method not only for the detection of the presence, but likewise for the quantitative determination of the nitrites under different circumstances, but especially in the case of natural waters, for which it is peculiarly suitable. The reaction referred to is that of nitrous acid, or of a soluble nitrite, on the well-known substance, gallic acid; thus when an aqueous solution of that latter acid is brought in contact with a soluble nitrite, the mixture, unless the amount of the latter present be very small, will soon acquire a yellow or yellowish-brown tint, which will increase in depth up to a certain point, after which the colour remains permanent, whilst, at the same time, minute globules of gas make their appearance in the mixture. If, however, the quantity of nitrate present be exceedingly small, it will require several hours, or even some days, to complete the reaction at the ordinary temperature. By the application, however, of heat,† and bringing the mixture to the boiling-point, even in the case of the most dilute solutions, the reaction will be completed in a few moments. This development of colour under the circumstances stated is evidently due to the oxidation of the gallic acid, at the expense of the nitrous acid, whereby the compound known under the name of tanno-melanic acid seems to be formed, whilst nitric oxide and carbonic acid gases are evolved. The following equation represents the changes which occur in the reaction :—

Gallic Acid.	Nitrous Acid.	Tanno-Melanic Acid.	Carbonic Acid.	Nitric Oxide.	Water.

$$C_7H_6O_5 + 2HNO_2 = C_6H_4O_3 + CO_2 + 2NO + 2H_2O.$$

These changes, with the development of colour, take place in neutral as well as in acid solutions, but more readily in the latter, and when they are heated than at the ordinary temperature, as already observed. The colouring principle which is so produced seems to be the same substance that is formed by the gradual oxidation of gallic acid in aqueous solution by exposure to the air; or when this takes place more rapidly, by the solution being rendered alkaline by the addition of one of the alkalies before exposing it to its influence. The colouring matter so formed is unaffected by diluted acids—at least diluted sulphuric, nitric, and hydrochloric acids had no apparent effect on it; and the organic acids, acetic, oxalic, and tartaric, even in a concentrated condition, did not seem to produce any change. It is also very permanent, and does not appear to be affected by exposure to the air and light, even after being for a long time subjected to their influence.

The depth or intensity of the colour produced being in direct proportion to the amount of nitrite reacting on the gallic acid, a ready means is afforded for the quantitative determination of the nitrites. Thus, if a standard solution be prepared, containing a known quantity of nitrite, and if a given amount of water or solution under examination yielded with gallic acid a certain shade or depth of colour, and if the same bulk of the standard solution, or of a mixture of it with distilled water in known proportion, developed the same tint, the former would be considered to contain the same amount of nitrite as the latter, and by thus comparing the tints produced by the waters under examination with those caused by solutions containing known quantities of nitrite, the quantitative estimation of such may be quickly accomplished, just as in Nessler's process (now so much employed by chemists) the determination of ammonia is so readily effected. Indeed the colour which is developed by the action of the nitrites on

* A paper read before the Royal Irish Academy. April 24, 1882.

† The continued application of heat has the effect of slightly diminishing the depth of colour developed in this reaction.

gallic acid most closely resembles that produced by ammonia on Nessler's reagent. The process, too, is conducted pretty much in the same way, except that we have a standard solution of an alkaline nitrite, instead of one of ammonia; and the test reagent is one containing gallic acid, instead of Nessler's solution; and finally, that the water or mixture, after the addition of the gallic acid solution, and a few drops of either sulphuric or hydrochloric acid, is heated to boiling in a test-tube and allowed to cool, after which it is placed in a cylindrical flat-bottomed glass, to compare more accurately the degree of colour produced by the water under examination with that containing some known quantity of nitrite.

The gallic acid solution which I have employed for the determination of nitrites is a strong or saturated aqueous one, which, if not colourless, can be easily made so by boiling it for a few minutes with animal charcoal, filtering the mixture whilst still warm, and then adding immediately to the filtrate sufficient sulphuric or hydrochloric acid to render it strongly acid, which addition I have found prevents, to a great extent, the tendency of aqueous solutions of gallic acid to become of a yellow or brownish tint on keeping, which well-known property is due, as already observed, to the tendency of that acid to oxidise under such circumstances; but by the addition of the acids stated, I have kept solutions of gallic acid, which were even exposed to the air in open vessels, for over two months without undergoing any change in colour.

As to the standard alkaline nitrite solution, it may be readily prepared by decomposing a hot aqueous solution of silver nitrite with potassium or sodium chloride, and after the subsidence of the silver chloride formed, diluting the solution to the required amount. The one I employed was made, as Dr. Frankland directs in his "Water Analysis," for the preparation of the standard alkaline nitrite solution to be employed in Griess's method for the determination of nitrites, which is prepared as follows:—0·406 grm. of pure silver nitrite is dissolved in boiling distilled water, and pure potassium or sodium chloride added, till no more silver chloride is precipitated. The solution is made up to one litre, and the silver chloride being allowed to settle, 100 c.c. of the clear solution is made up to one litre, of which 1 c.c. is equivalent, as he says, to 0·01 m.grm. of nitrous anhydride (N_2O_3); and he further adds, that this solution should be kept in closely-stoppered bottles, quite full. A solution at least double this strength will, however, be found more convenient for my test. I may also observe that I have likewise used a standard solution made by taking the commercial potassium nitrite and boiling it along with alcohol, which will dissolve out the potassium nitrite, leaving undissolved the nitrate and other impurities; and this alcoholic solution, on evaporation and drying the residue, will furnish the nitrite suitable for this purpose.

In using this test a convenient quantity of water to employ is 25 c.c., which can easily be heated in a test-tube of somewhat larger capacity, along with 1 or 2 c.c. of the gallic solution, and a few drops of sulphuric or hydrochloric acid, and, when the mixture has cooled, transferring it to a flat-bottomed cylindrical glass, where the depth of colour can be more readily determined, and compared with that yielded by equal bulks of different mixtures of the standard solution with distilled water. But where the amount of nitrite is very minute, it will perhaps be better to use at least 50 c.c. of the water under examination. I should observe that the nitrates do not produce the reaction described with gallic acid, and, unless they are present in large quantity, do not affect the test; and that it (the reaction with the nitrites) appears to be uninfluenced by the presence of the different saline and earthy salts that occur in natural waters, as well as by the organic matters that may be there occasionally. It might be naturally supposed that soluble salts of iron (which are sometimes present to some extent in certain waters), producing as they do the well-known black or ink like reaction with gallic acid, would preclude its employment as a means of estimating nitrites, where the former salts were present; but this is not the case, for the iron may be separated by the addition of ammonia and filtration, after which I have found that the filtrate, having been acidified, may be treated with gallic acid, for the estimation of nitrites. It appears, therefore, that none of the substances which would be likely to occur in natural waters interfere with the employment of this test.

As to what may be the exact limits of its indications, I have not yet been able to determine; but I have readily detected, by its use, an amount of nitrite in water equivalent to one part of nitrous acid in about twenty million parts of water.

I have made a number of comparative experiments with this test of mine and those hitherto proposed for nitrites, but chiefly with that of P. Griess, already referred to, as Dr. Frankland (who is one of the first chemists of the day) has stated in his "Water Analysis," that it is the only trustworthy means we have for the estimation of nitrites.

This test, I may briefly say, depends on the reaction of nitrous acid on metaphenylene diamine, or meta-diamidobenzol, a derivative of benzol, whereby an orange-coloured compound is produced, by the oxidation of this complex basic substance. This reaction is one of extreme delicacy, and the test is carried out pretty much in the same manner as the well-known Nessler's method for the determination of ammonia; or of mine, just described, for that of nitrites; the depth of colour produced by the test solution, with the water under examination, being compared with that of one containing a known quantity of nitrite; the details, however, of the method will be found fully stated in Dr. Frankland's "Water Analysis."

From several comparative experiments I have made with Griess's method and that of my own, I have come to the conclusion that the latter is almost, if not quite, as delicate a test for the nitrites as the former. I have, however, observed this difference between them, that when the proportion of nitrites present was considerable, that then Griess's test gave a more decided reaction, or that the colour produced was of greater intensity than in the case of the gallic acid test; but that when the amount of nitrite was exceedingly minute, that then there was but little or no difference in the delicacy of their indications. In some other respects, however, the test which I have proposed possesses advantages over that of Griess; thus the metaphenylene diamine is at present a compound very difficult to be procured; so much so that though I applied twice, lately, to one of the best known firms in London for the manufacture of chemicals (Messrs. Hopkin and Williams), they were unable to procure me a little of that substance; and that which I operated on was kindly given to me by my friend Dr. Tichborne, who procured it direct from Berlin. On the other hand, the reagent used in my test may be got for a few pence at any druggist's shop. Again, Griess's test solution will not keep, as it quickly acquires the same colouration that is produced by the reaction of nitrous acid or a nitrite on it, even when it is kept in closely-stoppered bottles; and therefore requires to be freshly made and titrated almost every time it is employed; whereas the gallic acid solution which I have recommended will, I find, keep for a very considerable time without apparently undergoing any alteration requiring its fresh titration, which is an important advantage. In conclusion, I may add, that whatever may be the comparative merits of the two tests contrasted, I have but little doubt that the one I have proposed will be found to be a useful and expeditious method for both the qualitative and quantitative determination of the nitrites under different circumstances.

Determination of Carbon Disulphide.—E. A. Grete and J. Macagno.—Both authors ascertain the quantity of copper which can be precipitated by the xanthogenic acid obtained on treating the carbon disulphide with alcoholic solution of potassa.—*Zeitsch. f. Anal. Chemie.*

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Zirconia.

The boiling solution is treated with an excess of solution of potassa. The precipitate of zirconia requires prolonged washings, and retains traces of gallia, which are extracted by re-solution in hydrochloric acid and re-precipitation by potassa. Two or three treatments with boiling potassa generally suffice. The gallium oxide is freed from potassic salts by supersaturation, first with hydrochloric acid, and then with ammonia and prolonged boiling, or more accurately by means of cupric hydrate. Only feeble traces of zirconia pass into the alkaline solution, which are separated from gallium by potassa at the end of the analysis.

Arsenic sulphide also effects the separation of zirconium and gallium, and especially to detect small traces of gallium masked by much zirconium. The liquid charged with acid ammonium acetate and arsenious acid is treated with sulphuretted hydrogen, as already indicated.

Ferrocyanide cannot be used, as it gives a canary-yellow precipitate in solutions of zirconia, even if very acid and very dilute. Ebullition even does not effect the solution of the precipitate in a liquid containing two-thirds of its bulk of concentrated hydrochloric acid. This fact is mentioned because certain chemical treatises assert that potassium ferrocyanide gives a precipitate in neutral solutions of zirconium, but not in such as are acid.

Separation from Manganese.

The author has found the nine following methods effective:—

1. He treats the boiling liquid with an excess of aqueous potassa. The precipitate contains a quantity of gallium, and is re-dissolved in hydrochloric acid and treated afresh with potassa. This process is repeated four or five times; the alkaline solutions collected together are concentrated and filtered to separate a little brown manganese oxide. The gallium is removed from the alkaline salts by ebullition with ammonia, or with cupric hydrate. If the proportion of manganese is very considerable this process loses much of its advantage, because of the difficulty of washing completely the bulky deposits of manganese oxide.

2. The hydrochloric solution, distinctly acid, is kept at a boil for some minutes (which reduces the manganese per-salts); it is then supersaturated with ammonia, and boiled until it reddens litmus-paper; the water lost by evaporation is constantly replaced. The gallium oxide obtained sometimes retains traces of brown manganese oxide; it is then re-dissolved in hydrochloric acid, and the ammoniacal ebullition is repeated, taking care not to add the ammonia until the acid liquid has boiled for a few minutes.

3. Barium carbonate separates gallium in the cold in twelve to eighteen hours, leaving manganese chloride dissolved. Traces of manganese may be found in the precipitate, but they are eliminated after the separation of the barium and gallium by means of boiling with ammonia or cupric hydrate.

4. Calcium carbonate may be used in the same manner as barium carbonate.

5. If iron is present it is advisable to eliminate a good part of this metal at the same time as the manganese. For this purpose the hot acid liquid is reduced by sulphurous acid gas or sodium sulphite. After boiling for a few moments the author adds a small excess of calcium carbonate, and filters. The separation of the calcium and gallium is effected in the ordinary manner. This method is especially useful in extracting gallium from its ores.

6. Cupric hydrate, applied hot, affords an excellent means for separating gallium from manganese. The process is conducted as has been previously described.

7. In presence of iron the liquid may be first reduced by metallic copper and the gallium precipitated by means of the cuprous oxide. This process is as accurate as that with cupric hydrate.

8. When the quantity of gallium is very small in comparison with the mass of manganese salts, it is sometimes advantageous to use the reaction of arsenic sulphide formed in a solution supersaturated with acid ammonium acetate. Manganese sulphide is not formed under these conditions. The separation is very good.

9. The reaction of potassium ferrocyanide is applicable to the precipitation of gallium mixed with manganese compounds, but it is necessary to operate in an especial manner, for the presence of manganese chloride modifies the action of ferrocyanide upon gallium chloride. If we divide into two equal parts a very dilute and very acid solution (containing one-third of its volume of hydrochloric acid) of gallium chloride, and introduce into one of the halves manganese chloride, the addition of equally very small quantities of ferrocyanide produces very different effects in the two vessels. The solution of gallium alone becomes abundantly turbid, whilst the solution containing manganese remains at first clear, and then slowly deposits a reddish brown precipitate which contains the gallium. This brown precipitate is re-dissolved if heated with its mother-liquid, and is slowly reproduced on cooling. The precipitate formed in the liquid free from manganese does not dissolve in its mother-liquid if raised to a boil, but it dissolves in heat if some manganese chloride is previously added to the mother-liquor. After cooling, the reddish brown precipitate is then gradually produced.

If, instead of pouring very little prussiate into the solution of gallium and manganese, we add much, the brown precipitate is formed at once, but retains its property of being dissolved in heat and re-precipitated when cold.

If a clear, very acid solution, containing gallium chloride, an excess of manganese chloride, and ferrocyanide, is kept at a temperature of 70° to 80°, there is soon formed a turbidity, not brown, but white with a blue cast; it is in appearance the ordinary precipitate of gallium ferrocyanide, but it does not dissolve if heated with the excess of the salt of manganese. This precipitate contains all the gallium. In the liquid, when cold, the deposit does not turn brown. By operating as follows an accurate separation of gallium and manganese can be effected with ferrocyanide.

The solution containing about one-third of its volume of concentrated hydrochloric acid is raised to 70°; a quantity of ferrocyanide is then added, not too great, in order to avoid the formation of much Prussian blue, but still larger than if it was required to precipitate the same weight of gallium in the cold in presence of metals such as aluminium or chromium. The ferrocyanide should be neither too dilute, nor acidified with hydrochloric acid. Drops of moderately concentrated ferrocyanide give, on contact with the highly acid liquid, a white precipitate, which would be equally formed with hydrochloric acid alone, and which re-dissolves on stirring if the quantity of ferrocyanide is small. The momentary presence of this slight turbidity incites and accelerates the deposition of the gallium ferrocyanide. The liquid is stirred frequently, and is kept at about 70° for 30 to 60 minutes; then filtered, the deposit washed with water containing one-fourth hydrochloric acid, and heated to 70°. 0·001 grm. of gallium, corresponding to 0·0025 grm. of gallium chloride, may be recovered in this manner without appreciable loss, from 200 c.c. of a very acid solution containing 12·5 grm. of anhydrous manganese chloride. The limit of the sensibility of the process is not reached here, though the liquid contains merely 1-200,000th of gallium, and the gallium chloride bears to the manganese chloride the proportion 1 : 5000. If from deficient washing or otherwise the gallium ferrocyanide retains traces of manganese, these are naturally eliminated during the treatment necessary to separate gallium from iron, such as the boiling with ammonia of the product of the action of

bisulphate upon the oxides, and the action of metallic copper and cuprous oxide.

Separation from Zinc.

The hydrochloric solution, very strongly acid, is supersaturated with ammonia and boiled till it reddens litmus, the water driven off being replaced. Care must be taken that the liquid when cold does not cease to redden litmus, which will happen if traces of zinc oxide remain unattacked. If the gallium oxide retains a little zinc oxide it is re-dissolved by hydrochloric acid in excess and the boiling with ammonia is repeated.

Cupric hydrate separates gallium accurately from zinc. The process is conducted with the aid of heat, on principles already laid down. In case of need the operation is repeated. When, in addition to zinc, iron is present in the solution it is better to reduce with metallic copper and precipitate with cuprous oxide. The separation is as exact as with cupric hydrate. The zinc being much more readily eliminated than the iron, the latter metal is the chief object of concern.

Barium and calcium carbonates precipitate gallium oxide in the cold, but the deposits contain considerable quantities of zinc oxide, especially if barium carbonate has been used. These two reagents can only be employed when it is required to concentrate gallium into a small volume, and cannot be admitted in an exact analysis. The same observation applies to the precipitation of gallium by calcium carbonate at a boil after sulphurous reduction. There is much zinc in the deposit, however short the boiling has been, especially if the excess of calcium carbonate is considerable. The treatment with calcium carbonate in heat, after reduction with sulphurous acid, though not suitable for analysis is very advantageous for the extraction of gallium from its ores, since by repeating the process two or three times we may eliminate almost all the zinc, the greater part of the iron, and many other bodies.—*Comptes Rendus.*

A NEW METHOD OF DETERMINING PHOSPHORIC ACID.*

By HENRY PEMBERTON, Jun.

THE process I am about to describe, and which I first tried in the summer of 1879 and have used since that time, consists in titrating phosphoric acid by direct precipitation, by means of a standard solution of molybdate of ammonia.

The principle is the same as that of Gay-Lussac's silver estimation, or Wildenstein's estimation of sulphuric acid by barium chloride; the standard solution is run in until further addition no longer causes a cloud, and the volume then read off.

Any one who has used ammonic molybdate for separating P_2O_5 in the usual gravimetric determination will at once see that the following obstacles will have to be overcome:

(1). The usual nitric acid solution of the molybdate is not stable, and is therefore unfitted to act as a standard solution, on account of the gradual separation of molybdic acid.

(2). The yellow precipitate does not separate completely until after the lapse of considerable time.

3). A decided excess of the molybdate must be added to insure the complete precipitation of the P_2O_5.

(4). The precipitate has not always the same composition, being frequently mixed with free molybdic acid.

Two expedients have enabled me to overcome these difficulties: the use of an *aqueous* solution of ammonic molybdate, instead of the ordinary nitric acid solution—first advocated by John Parry (CHEMICAL NEWS, vol. xxv.)—and the addition to the phosphate solution of a considerable quantity of nitrate of ammonia, in which the yellow precipitate is as good as insoluble—recommended by E. Richters (*Journ. Chem. Soc.*, 24, p. 157).

By so doing I have found that the standard solution is perfectly stable, that the yellow precipitate falls immediately and completely, that a very small and definite excess (½ c.c.) of the molybdate is required, and that the ratio of molybdic trioxide to phosphoric anhydride is always the same.

Briefly stated, then, the process consists in adding nitrate of ammonia to the phosphate solution, using a limited quantity of nitric acid, and running in, from a burette, an aqueous solution of ammonic molybdate until, after the settling of the precipitate, the further addition of the standard solution leaves the liquid clear.

Starting out, as I did, completely in the dark, my first object was to get some general idea of the working of the proposed method. Therefore, without being exact in weights, I dissolved about 10 grms. of the molybdate in 100 c.c. of water, and made a phosphate of soda solution of such strength that 50 c.c. should equal 0·1000 grm. P_2O_5. 25 c.c. of this phosphate solution was then treated with 2 c.c. nitric acid, of 1·4 specific gravity, and with 10 grms. nitrate of ammonia. It was then heated, and the molybdate solution run in from a burette. The first drop caused an immediate precipitate. This was continued until, after settling of the yellow precipitate (which is quite rapid), further addition left the solution clear. I found, in three trials, that 25 c.c. of the phosphate solution required 15·8 c.c., 16·0 c.c., 15·7 c.c. of the molybdenum solution. This same was then repeated, but the final point was determined by filtering a little of the solution and testing it by the molybdate. 25 c.c. required 15·5 c.c., 15·3 c.c., 15·5 c.c., showing that in the first three trials, where the end of the reaction was shown by the settling of the precipitate, the point was somewhat overstepped. In all the following experiments, therefore, the end of the precipitation was determined by allowing the yellow salt to settle, filtering a little of the solution through a small filter, heating this clear filtrate, and testing it with more of the molybdate.

Nitric Acid.—Repeated above, using 5 c.c. HNO_3, 1·4 sp. gr., in place of 2 c.c. Required 16·0 c.c., 16·0 c.c., showing that a greater quantity of the molybdate is necessary in order to counteract the solvent action of the excess of nitric acid.

Ammonic Nitrate.—Proceeded as above, 2 c.c. HNO_3, but used 20 grms. ammonic nitrate in place of 10 grms., as before. Required 15·5 c.c., 15·5 c.c., proving that 10 grms. is sufficient when the total volume of the solution is not over 100 c.c., or thereabout.

Dilution.—As above, 10 grms. NH_4NO_3, 2 c.c. HNO_3, but diluted the solution so that the volume when finished equalled 130 c.c., instead of from 50 to 70 c.c., as above. Required 15·6 c.c., showing that dilution, within moderate limits, does not affect the result.

Oxides of Iron and Alumina.—As above, but added 0·057 grm. Fe_2O_3, dissolved as nitrate, and 0·034 Al_2O_3, present as neutral tersulphate. Required 15·5 c.c., proving that these sequioxides—at least when present in above quantities—do not interfere.

The above were all preliminary trials, made merely to enable me to feel my way. Feeling encouraged by the results, I proceeded to make a more thorough examination.

10·085 grms. disodic hydric phosphate were dissolved in water and made up to 1000 c.c. The amount of P_2O_5 in 50 c.c. of this solution was then determined by precipitation and weighing as magnesic pyrophosphate, and also by evaporating, igniting, and weighing as sodic pyrophosphate. I found in 50 c.c.—

By $Mg_2P_2O_7$	.. ..	0·1010 grm. P_2O_5
" "	.. ..	0·1009 " "
" $Na_4P_2O_7$	.. ..	0·1012 " "
Average =	..	0·10103 " "

* Read before the Chemical Section of the Franklin Institute, Feb. 7, 1882.

Showing that the salt before weighing had effloresced about 1 per cent.

93 grms. ammonic molybdate [$3(HN_4)_2O{\cdot}7MoO_3{\cdot}4H_2O$] were dissolved in water and made up to 1 litre, a slight cloudiness being removed by addition of a few drops of ammonic hydrate.

50 c.c. of the phosphate of soda solution were then measured into a beaker, treated with 10 grms. NH_4NO_3 and with one c.c. HNO_3, 1·40 sp. gr., and then warmed. Ammonic molybdate was then run in, but not a trace of a precipitate formed; but on adding another c.c. of nitric acid a dense precipitate immediately formed. After adding still a third c.c. of nitric acid 32·9 c·c. of the molybdate were required for entire precipitation. Using, therefore, 10 grms. NH_4NO_3, 2 c.c. HNO_3, 1·4 sp. gr., and titrating with the solution of 93 grms. molybdate to the litre, I found that 50 c.c. P_2O_5 solution required, when the volume at the end was

115 c.c. .. .. 32·5 c.c.
32·8 c.c. } Mean = 32·70 c.c.
32·7 c.c.

When the volume at the end was

60 c.c. to 70 c.c. .. 32·8 c.c.
32·9 c·c. } Mean = 32·85 c.c.

Again, when volume = 120 c.c.,

33·0 c.c.
32·8 c.c. } Mean = 32·90 c.c.

The means, therefore, were: 32·70 c.c.
32·85 c.c.
32·90 c.c.

General mean = 32·82 c.c.

to precipitate 0·1000 grm. P_2O_5. Therefore 0·1000 grm. P_2O_5 would require 32·48 c.c.

It is well known that in the usual way of precipitating this yellow salt, where a large quantity of nitric acid is present, a considerable excess of the molybdate is required. Having this in view, I tried the following experiment. Since 50 c.c. of the P_2O_5 solution require, as above, 32·82 c.c. molybdate, 5 c.c. should require one-tenth of this, or 3·28 c.c. I found, however, that 5 c.c. required, in two trials, 3·7 c.c. and 3·7 c.c, an excess of 0·42 c.c. Again, 1·5 c.c. P_2O_5 solution (= 3 per cent. of 50 c.c.) should require 3 per cent. of 32·82 c.c. = 0·98 c.c. By experiment 1·45 c.c. were required, an excess of 0·47 c.c. As it is not required to differentiate more finely than to the 1-10th c.c., it appears that 0·5 c.c. excess is required, first to neutralise the slight solvent power of the HNO_3 present, and secondly to precipitate the small quantity of P_2O_5 held back in the pores of the filter paper in the final testing. Subtracting, therefore, this 0·5 c.c., we find that 0·10103 grm. P_2O_5 require 32·82 c.c. − 0·5 c.c. = 32·32 c.c. Therefore 0·1000 grm. P_2O_5 require 32·00 c.c. molybdate.

Ratio of MoO_3 *to* P_2O_5.—Ammonic molybdate contains, when perfectly pure, 81·55 per cent. MoO_3. One determination of the sample I used (of German manufacture) gave me, by Chatard's method, 81·27 per cent. MoO_3. Using the theoretical figures, a litre of molybdate solution containing 93 grms. will contain 75·8415 grms. MoO_3. 32 c.c., therefore, will contain 2·4269 grms. MoO_3, this representing the amount required to precipitate 0·1000 grm. P_2O_5. Therefore $MoO_3 : P_2O_5 :: 24{\cdot}269 : 1$. This represents the ratio *by weight*.

Dividing by the molecular weight of each (144 and 142 respectively) we get 23 93-100ths molecules* of MoO_3 to 1 molecule P_2O_5, or practically 24 to 1.

This is precisely the figure established by Finkner, and still more recently by Dr. Gibbs in his investigation into the phospho-molybdates, just published in a recent number of the *American Chemical Journal*.

* Even if calculated upon the basis of 81·27 per cent. MoO_3 in the molybdate (as per my analysis), the result is practically the same, viz.: 23 85-100ths MoO_3 to P_2O_5.

The agreement of these results, obtained in entirely different ways (those of Finkner and Gibbs by analysis, mine by synthesis) prove what I previously asserted in regard to the constancy and reliability of results by this process. In the ordinary gravimetric determination of P_2O_5, where the latter is separated by the nitric acid solution of the molybdate, the solution has to stand in the heat for several hours and in the presence of a decided excess of the reagent. It is therefore impossible to guarantee the admixed molybdic acid, and almost every chemist analysing the per cent. of P_2O_5 in the yellow salt obtained a different result. It is, accordingly, this fact that has prevented the universal adoption of the yellow precipitate as a basis upon which to calculate the phosphoric acid.

I have, therefore, gone somewhat minutely into this question, to prove that these sources of error do not exist in this volumetric process.

Action of Nitric Acid.—I found that 50 c.c. of the P_2O_5 solution require—

(With 1 c.c. HNO_3 1·4 sp. gr.— no precipitate)
" 2 " " " 32·8 c.c.
" 3 " " " 32·9 "<br>" 5½ " " " 33·2 "<br>" 10½ " " " 33·8 "—is not enough.

Action of Chlorides.—10 c.c. P_2O_5 solution should require 6·46 c.c. With 5 grms. NH_4Cl added required in two trials 6·60 and 6·65 c.c. Again, 10 c.c. P_2O_5 solution with 1·17 grm. $CaCl_2$ added require 6·55 c.c. Again, 5 c.c. of another P_2O_5 solution which should require 4·90 c.c., when treated with 1 c.c. HNO_3 and 1 c.c. strong HCl, requires 4·90 c.c. Hence chlorides do not seem to have any appreciable effect.

Temperature.—The solution containing the phosphate has to be quite hot; a steam should play upon the surface of the liquid. One determination showed 136° F.; this should certainly be regarded as the minimum. A solution of known strength, to which about 90 per cent of the molybdate required had been added, and which had been kept only slightly warm, was filtered, and the filtrate heated. A decided yellow precipitate at once formed. From 140° to 160° F., or even somewhat higher, appears to be about the correct temperature.

Action of Silicic Acid.—Halloysite was decomposed with sulphuric acid, the silica filtered, washed, and boiled repeatedly with HCl. Again washed, dried, and ignited. 0·1725 grm. of this ignited silica was fused with Na_2CO_3, dissolved in water, neutralised with HNO_3, treated with 10 c.c. P_2O_5 solution, and then titrated. It should have required 6·45 c.c. molybdate, but did require 7·5 c.c., and even when 8·7 c.c. had been added, gave with more molybdate, at first a yellow colour, and after standing, a faint cloud. Silicic acid therefore interferes.

Action of Organic Matter.—The material used for this purpose is what is known in the trade as "azotine" or "ammonite." Refuse from slaughter-houses, dead animals, &c., are subjected to a treatment with hot benzine, by which the fat is extracted. The residue consists of a certain amount of bone with every variety of organic matter except the fat, and as it comes into the market in a fine dry powder, is well adapted to examination, weighing, &c. It was with particular reference to the analysis of fertilisers that I selected this substance as a typical form of organic matter likely to be found in these.

Before examining this, there are a few points to be noticed. First, Mulder has shown (*Chem. Gazette*, vii., p. 62) that higher results are obtained by treating organic compounds containing phosphorus with HNO_3 than are obtained by dissolving in HCl. He finds that the excess of P, oxidised by HNO_3 over the quantity dissolved by HCl, and calculated into phosphoric acid, to be, with albumen, 0·99 per cent, albumen in blood 0·76 per cent, fibrin 0·76. It has not been established that phosphorus, in organic combination, is of any value as plant-food. In fact, from the nature of the case, it never will be decided.

Secondly. Although shown by Kastner to be the case

over half a century ago, it is, in all probability, not generally known that the phosphoric acid in calcined bones exists not as ortho-phosphoric acid, but chiefly as pyro- or meta-phosphoric acid; and this, too, in spite of the fact that three atoms of base are present.

Thirdly. In igniting the azotine, to burn off the organic matter, the small quantity of dirt, sand, &c., always present yields a certain amount of soluble silicic acid, on subsequent treatment with acid, and this will interfere, unless the solution is evaporated to dryness.

The following are the analyses of several brands of this azotine:—By "volumetric" is meant that the determination is made by titration with ammonic molybdate. By MoO_3 and MgO that the usual gravimetric method was used.

Volumetric. Ignited azotine, evaporated to dryness,	14·19 per cent	P_2O_5.
,, ,, ,, not ,,	14·50 ,,	,,
,, ,, ,, not ,, (2nd analysis)	14·64 ,,	,,

showing the action of silica.

Volumetric. Raw azotine (not ignited) dissolved in HNO_3, evaporated twice .. 15·05 per cent.

showing the action of oxidising agents.

Another sample gave—

MoO_3 and MgO., raw azotine, HCl solution,	2·87 per cent	P_2O_5.
Volumetric ,, ,, ,, ,,	2·73 ,,	,,
,, ,, (repeated) ..	2·67 ,,	,,
,, Ignited, evaporated to dryness	2·90 ,,	,,
,, Same repeated	3·06 ,,	,,
,, Ignited (not evap., action of SiO_2)	3·20 ,,	,,

Another sample—

MoO_3 + MgO raw azotine	4·45 per cent	P_2O_5.
Volumetric ,, ...	4·57 ,,	,,
,, ,, HNO_3 + $KClO_3$	5·21 ,,	,,
,, Same repeated, ...	5·60 ,,	,,
,, Ignited but not evaporated,	4·84 ,,	,,
,, Same repeated, ...	4·91 ,,	,,

I now made a mixture of acid phosphate of lime from South Carolina phosphate rock and sulphuric acid, containing (about)

9	per cent soluble P_2O_5
3½	,, reverted ,,
2½	,, insoluble ,,
15	per cent total.

This was mixed so as to contain in 100 parts of the above acid

Phosphate	79 parts
Azotine	16 ,,
Potassium chloride	5 ,,
	100 ,,

and this mixture, after being finally ground and averaged, was analysed as follows:—

By MoO_3 + MgO (not ignited) ..	13·32 per cent	P_2O_5
Volumetric, ignited, evaporated to dryness	13·25 ,,	,,
(Showing no loss from formation of pyprophosphate).		
Volumetric, not ignited, HCl solution evaporated	13·11 ,,	,,
	13·07 ,,	,,
	13·24 ,,	,,
Volumetric, not ignited, HCl solution *not* evaporated	14·03 ,,	,,

Again, the above mixture was leached, filtrate not measured, but 25 c.c. (=about 0·8 grm.) taken for each trial.

By MoO_3 + MgO (evaporated to dryness with HCl)	70·7 mgr.	P_2O_5
Volumetric, ,, ,, ,, ..	69·3 ,,	,,
,, not evaporated	71·1 ,,	,,

From the above it appears that by dissolving in HNO_3 and evaporating to dryness, the results are above the truth; by dissolving in HCl, the result may be 0·1 per cent to 0·2 per cent low; by igniting and not evaporating, the silica will interfere; but that by igniting and evaporating to dryness the results are correct, or vary only within the limits of instrumental errors.

I have observed no difficulty in working with pyrophosphates, provided that the ignition be carried on at not too high a temperature, and the evaporation with nitric acid be repeated.

Citric, tartaric, and oxalic acids interfere and must not be present. When the oxalic acid is oxidised by permanangate, the yellow precipitate falls immediately.

The following is a condensed description of the *modus operandi* in performing the analysis.

89·5430 grms. ordinary ammonic molybdate are put into a litre flask, water added, and the whole shaken until the salt dissolves. If a cloudiness is left in the liquid, a little ammonic hydrate is added. A small excess of this is not objectionable. The flask is then filled to the mark.

The above weight of the molybdate is calculated so as to give MoO_3 to P_2O_5 exactly as 24 : 1. Each c.c. precipitates 3 milligrammes P_2O_5. It differs from the figure obtained empirically by an amount equal to only 0·0003 grm. P_2O_5 in a determination of 0·1000 grm. P_2O_5.

The phosphate to be examined is then taken in quantity containing not over 0·1000 grm. P_2O_5 or 0·1500 grm. at the utmost. If silica is present the solution is evaporated to dryness. In presence of organic matter ignite gently and evaporate to dryness twice with HNO_3. There is no advantage in filtering off the SiO_2. The solution is transferred to a beaker of 100 to 125 c.c., using as little water as possible to prevent unnecessary dilution, and is just neutralised with NH_4HO, *i.e.*, until a slight precipitate is formed.

If much iron is present the ammonia is added until the yellow colour *begins* to change to a darker shade. 2 c.c. of nitric acid are added. Care must be taken that the sp. gr. of the acid is not less than 1·400, otherwise more must be added. 10 grms. of granular nitrate of ammonia are now added. After a little experience the quantity can be judged with sufficient accuracy by the eye without the trouble of weighing. The solution is now heated to 140° F. or over and the molybdate solution run in (most conveniently from a Gay-Lussac burette), meanwhile stirring the liquid. The beaker is now left undisturbed for about a minute on the water-bath or hot plate and the precipitate settles, leaving the supernatant liquid not clear but containing widely disseminated particles, in which the yellow cloud can easily be seen on the further addition of the molybdate. This addition is continued as long as the precipitate is thick and of a deep colour. But as soon as it becomes rather faint and thin, a little of the solution, about 2 to 3 c.c., after settling of the precipitate, is filtered through a small filter (not over 5 c.m. in diameter) into a very small beaker, and this is heated on a hot plate and 4 or 5 drops of the molybdate added. If a precipitate is produced the whole is poured back into the large beaker and a further addition of the molybdate (1, 2, or 3 c.c.) added, according to the quantity of the precipitate in the small beaker. After stirring and settling, another small quantity is filtered through the small filter and again tested. If the mark has been overstepped and too much molybdate added, a measured quantity of P_2O_5 solution of known strength is added, and the corresponding amount of P_2O_5 deducted. In filtering through the small filter the liquid held sometimes in the neck of the funnel must be allowed to run out.

I generally check my results by adding a c.c. of standard P_2O_5 solution, and then again testing. This can be re-

peated as often as desired. The portion that *last* produces a cloud is the final point. From this is subtracted 0·5 c.c. (for neutralising the solvent action of the HNO_3, as above explained), and the remainder multiplied by 3 gives the weight of P_2O_5 in milligrammes.

One decigramme of P_2O_5 gives about 2¾ grms. of the yellow precipitate, and the accuracy of the process is largely due to this smallness of the percentage of the P_2O_5.

The ammonic molybdate is now prepared in a state of great purity. Several samples that I have bought did not vary in strength to any appreciable extent. It may, possibly, contain a trace of phosphoric acid, which, however, does not affect the result, since it will have the same weakening action in the standardising tests that it has in the actual analysis.

I have used this process entirely in determining phosphoric acid in materials containing it in quantity, *e.g.*, apatite phosphate rock, fertilisers, &c.

It is *not* adapted to the direct determination of minute quantities of phosphorus in iron or iron ores. At least 5 grms. of the ore must be taken, and in the concentrated solution formed by this quantity of the iron salt and the nitrate of ammonia, the precipitate settles slowly on account of the density, and is seen with difficulty because of the depth of colour. Moreover, I have observed that a solution of ferric nitrate shows a somewhat peculiar behaviour on addition of ammonic molybdate; molybdic acid at once separates in a curdy precipitate which redissolves on stirring. This reaction does not take place when iron is absent. Ferric nitrate, moreover, has the effect of retarding the precipitation somewhat, and it, therefore, is more difficult to see how the precipitation is proceeding when Fe_2O_3 is present in quantities exceeding a decigramme or so. These properties are peculiar to iron oxide only, and not to alumina.

In working with unknown quantities the titration requires about an hour for its performance. Of all the forms of volumetric analysis, that one in which the final point is determined by the cessation of the precipitation is the least desirable. And were it not that the ordinary method requires a day rather than an hour (including at least two precipitations of the magnesia salt), the process of direct precipitation above described would hardly be able to hold its own in comparison.

I have obtained very sharp and accurate results by determining the amount of the yellow precipitate (formed as above, after thorough washing), by means of a standard solution of caustic alkali, using litmus as an indicator; a description of which I hope to present in a future paper. I mention it here simply to place the fact on record.—*Journal of the Franklin Institute.*

RULES AND REGULATIONS RECOMMENDED FOR THE PREVENTION OF FIRE RISKS FROM ELECTRIC LIGHTING.*

Members of the Committee.—Professor W. G. Adams, F.R.S., Vice-President; Sir Charles T. Bright; T. Russell Crampton; R. E. Crompton; W. Crookes, F.R.S.; Warren De la Rue, D.C.L., F.R.S; Professor G. C. Foster, F.R.S., Past President; Edward Graves; J. E. H. Gordon; Dr. J. Hopkinson, F.R.S.; Professor D. E. Hughes, F.R.S., Vice-President; W. H. Preece, F.R.S., Past President; Alexander Siemens; C. E. Spagnoletti, Vice-President; James N. Shoolbred; Augustus Stroh; Sir William Thomson, F.R.S., Past President; Lieut.-Colonel C. E. Webber, R.E., President.

* Recommended by the Council of the Society of Telegraph Engineers and of Electricians in accordance with the Report of the Committee appointed by them on May 11, 1882, to consider the subject.

THESE rules and regulations are drawn up not only for the guidance and instruction of those who have Electric Lighting Apparatus installed on their premises, but for the reduction to a minimum of those risks of fire which are inherent to every system of artificial illumination.

The chief dangers of every new application of electricity arise mainly from ignorance and inexperience on the part of those who supply and fit up the requisite plant.

The difficulties that beset the electrical engineer are chiefly internal and invisible, and they can only be effectually guarded against by "testing" or probing with electric currents. They depend chiefly on leakage, undue resistance in the conductor, and bad joints, which lead to waste of energy and the production of heat. These defects can only be detected by measuring, by means of special apparatus, the currents that are, either ordinarily or for the purpose of testing, passed through the circuit. Bare or exposed conductors should always be within visual inspection, since the accidental falling on to, or the thoughtless placing of other conducting bodies upon, such conductors might lead to "short circuiting" or the sudden generation of heat due to a powerful current of electricity in conductors too small to carry it.

It cannot be too strongly urged that amongst the chief enemies to be guarded against are the presence of moisture and the use of "earth" as part of the circuit. Moisture leads to loss of current and to the destruction of the conductor by electrolytic corrosion, and the injudicious use of "earth" as a part of the circuit tends to magnify every other source of difficulty and danger.

The chief element of safety is the employment of skilled and experienced electricians to supervise the work.

I. THE DYNAMO MACHINE.

1. The Dynamo Machine should be fixed in a dry place.
2. It should not be exposed to dust or flyings.
3. It should be kept perfectly clean and its bearings well oiled.
4. The insulation of its coils and conductors should be perfect.
5. It is better, when practicable, to fix it on an insulating bed.
6. All conductors in the Dynamo Room should be firmly supported, well insulated, conveniently arranged for inspection, and marked or numbered.

II. THE WIRES.

7. Every switch or commutator used for turning the current on or off should be constructed so that when it is moved and left to itself it cannot permit of a permanent arc or of heating, and its stand should be made of slate, stoneware, or some other incombustible substance.
8. There should be in connection with the main circuit a safety fuse constructed of easily fusible metal which would be melted if the current attain any undue magnitude, and would thus cause the circuit to be broken.
9. Every part of the circuit should be so determined that the gauge of wire to be used is properly proportioned to the currents it will have to carry, and changes of circuit, from a larger to a smaller conductor, should be sufficiently protected with suitable safety fuses so that no portion of the conductor should ever be allowed to attain a temperature exceeding 150° F.

N.B.—These fuses are of the very essence of safety. They should always be enclosed in incombustible cases. Even if wires become perceptibly warmed by the ordinary current, it is a proof that they are too small for the work they have to do, and that they ought to be replaced by larger wires.

10. Under ordinary circumstances complete metallic circuits should be used, and the employment of gas or water pipes as conductors for the purpose of completing the circuit should in no case be allowed.
11. Where bare wire out of doors rests on insulating supports it should be coated with insulating material, such

as india-rubber tape or tube, for at least two feet on each side of the support.

12. Bare wires passing over the tops of houses should never be less than seven feet clear of any part of the roof, and they should invariably be high enough, when crossing thoroughfares, to allow fire escapes to pass under them.

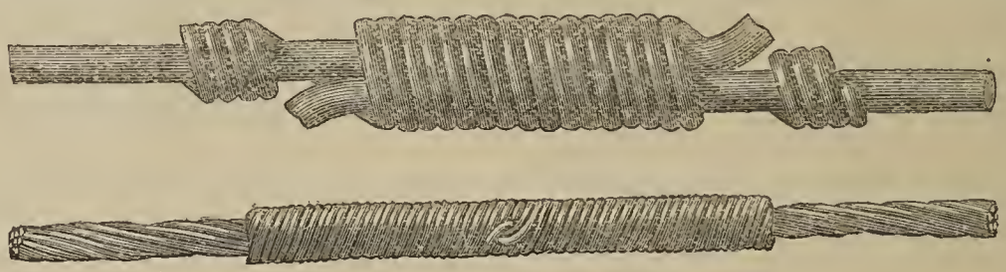
13. It is most essential that the joints should be electrically and mechanically perfect. One of the best joints is that shewn in the annexed sketches. The joint is whipped around with small wire and the whole mechanically united by solder.

14. The position of wires when underground should be efficiently indicated, and they should be laid down so as to be easily inspected and repaired.

15. All wires used for indoor purposes should be sufficiently insulated.

16. When these wires pass through roofs, floors, walls, or partitions, or where they cross or are liable to touch metallic masses like iron girders or pipes, they should be thoroughly protected from abrasion with each other or with metallic masses, by suitable additional covering; and where they are liable to abrasion from any cause or to the depredations of rats or mice, they should be sufficiently encased in some hard material.

17. Where wires are put out of sight as beneath flooring, they should be thoroughly protected from mechanical injury, and their position should be indicated.



N.B.—The value of frequently testing the wires cannot be too strongly urged. It is an operation, skill in which is easily acquired and applied. The escape of electricity cannot be detected by the sense of smell as can gas, but it can be detected by apparatus far more certain and delicate. Leakage not only means waste, but in the presence of moisture it means destruction of the conductor and its insulating covering, by electric action.

III. Lamps.

18. Arc lamps should always be guarded by proper lanterns to prevent danger from falling incandescent pieces of carbon, and from ascending sparks. Their globes should be protected with wire netting.

19. The lanterns and all parts which are to be handled should be insulated from the circuit.

IV. Danger to Person.

20. To secure persons from danger inside buildings, it is essential so to arrange the conductors and fittings, that no one can be exposed to the shocks of alternating currents exceeding 60 volts; and that there should never be a difference of potential of more than 200 volts between any two points in the same room.

21. If the difference of potential within any house exceeds 200 volts, whether the source of electricity be external or internal, the house should be provided outside with a "switch," so arranged that the supply of electricity can be at once cut off.

By order of the Council,
F. H. Webb, Secretary.

Offices of the Society,
4, The Sanctuary, Westminster,
June 21, 1882.

Caffeine.—M. Tanret denies the existence of salts of caffeine containing organic acids. Such acids augment the solubility of caffeine in water, but are not neutralised by its presence.—*Journal de Pharmacie et de Chimie.*

NOTE ON FILTERING DISCS.

By P. CASAMAJOR.

In the Chemical News of April 21st (vol. xlv., p. 167), Mr. Grosjean refers to the plan proposed by him in 1879, (Chemical News, vol. xxxix., p. 182), of using ordinary conical funnels with the filtering discs described by me in 1875,* instead of the special funnel I had proposed. When Mr. Grosjean first published this plan I tried it, and found it very good, provided the perforated platinum disc is placed perpendicularly to the axis of the funnel. This condition is easily fulfilled by soldering, with gold, a platinum wire on the under side of the disc and perpendicular to it. If provided with this appendage the disc, when placed in the funnel, will drop into its proper position, as the wire, acting as a guide, will find its place in the stem of the funnel.

The idea of using a wire on a filtering disc for this purpose is due to Mr. J. Creagh Smith, who proposed it in the *American Chemical Journal*, vol. i., p. 368, for a cylindrical funnel, but it is equally applicable to a conical one.

Before dropping the platinum disc in the funnel, a circular piece of filter paper, slightly larger than the platinum plate, should be placed on its upper surface and thoroughly soaked with water. The wet paper will adhere to the platinum plate and drop down with it. The edges of the paper are then pressed against the funnel to form a tight joint all around the filtering disc.

A filtering disc covered with filter-paper, with a disc over this, forms a perfectly air-tight joint, with much less trouble than is required with a platinum cone and a conical filter. When a precipitate is to be collected for ignition, filtering discs, used in this way, present this objection, that the precipitate lies partly on the glass funnel, and it has to be brushed off or scraped off. The loss from this may be inappreciable if this is done carefully and skilfully, but this is certainly an objectionable trait.

This difficulty may be easily overcome by lining the funnel with filter-paper from near its top to about 5 millimetres below the filtering disc. This lining is easily made by cutting a piece of filter-paper into a semicircle, the radius of which is slightly less than the diameter of the funnel at the top. Out of this semicircle a smaller one is cut, the radius of which is about 5 millimetres less than the diameter of the filtering disc. This leaves a half ring, which is placed in the funnel, taking care that the edges overlap slightly. When this lining has been placed properly in the funnel it should have water poured over it to make it adhere to the funnel. The filtering disc, with a piece of wet paper on it, is then dropped in the funnel, and the edges of the paper disc are pressed against the paper lining of the funnel. The apparatus is then ready for filtration.

It will be found convenient to cut a number of pieces of paper, for lining the funnel, at one time. A tin-plate model may be made of the proper shape and used to cut the pieces of paper.

The stem of the funnel may be connected with any usual form of aspirator, but I find I get all the pressure I

* Chemical News, vol. xxxii., pp. 46, 184; *American Chemist*, vol. v., p. 440, and vol. vi., p. 124.

need by using a straight tube of small diameter from one to three feet long. With such a tube filtration is always more rapid than with ordinary conical filters, and a much smaller volume of water is required for washing the precipitate, as *all* the water passes *through* the precipitate, while, with ordinary filters, most of it passes *over* the precipitate. This is not only a gain in time but a reduction in the amount of liquid.*

To connect the aspirating tube with the stem of the funnel, the best plan is to draw out the end of this stem, so as to reduce its size, and to widen the upper end of the aspirating tube sufficiently to admit the attenuated end of the stem. A rubber tube is placed over the joint. By making the connection in this way, not only is the liquid prevented from touching the rubber tube, but this further advantage is obtained, that the suction tube becomes filled as soon as any liquid runs through the filter. If this should not happen at once, a slight tap on the side of the tube will secure the desired effect.

NOTE ON A NEW CATALYTIC REACTION.

By GEORGE WATSON, Jun., F.C.S.

The writer, in the course of some preliminary experiments on the ammoniacal compounds of the metal nickel, observed a curious case of the decomposition of hydrogen dioxide (into water and oxygen), which evidently belongs to that class of reactions termed "catalytic."

An aqueous ammoniacal solution of nickel sulphate ($NiSO_4$) had been prepared, by adding excess of ammonium hydrate to a sulphuricated, aqueous solution of that salt. The experiment, during the performance of which the reaction was observed, had for its object the ascertainment of answers to the following queries :—(*a*). If hydrogen dioxide be added to an ammoniated solution of a nickel salt, will the metal be oxidised into the state of per-salt, corresponding to the oxide Ni_2O_3? And (*b*), supposing this oxidation to be accomplished, does the nickel then exist in the form of an ammoniacal compound of the general formula $[Ni_2(SO_4)_{3x}](NH_3)y + ?Aq_z$, obtainable by gradual acidification with dilute sulphuric acid and subsequent evaporation.

The result of the experiment was that, on adding the hydrogen dioxide to the solution, a brisk evolution occurred of a gas, which was found to consist of oxygen. A red-hot splinter of wood, on being plunged into the atmosphere of the test-tube, immediately burst into flame. Now, according to theory, one would be justified in expecting an evolution of nitrogen gas, for if nickel sesquioxide were momentarily formed, it, in the presence of ammonium hydrate, would be converted into nickel hydroxide and oxygen, which would immediately produce, in reaction with its equivalent of ammonia, nitrogen and water, according to the well-known equation—

$$3Ni_2O_3 + 2NH_3 + 3H_2O = 6Ni(OH)_2 + N_2.$$

But this reaction does not take place, and consequently we must conclude that nickel peroxide is not produced, even instantaneously. This is therefore a case, pure and simple, of the splitting-up of hydrogen dioxide, produced by the proximity merely of another substance, which itself is not changed in any degree, and is analogous to the reaction between finely divided metallic silver and hydrogen dioxide. The same reaction also occurs when the dioxide is added to a suspension of nickel hydroxide in watery solution of sodium hydrate, produced by adding the latter to a solution of nickel sulphate, and it may therefore be assumed it would also take place by using pure and dry nickel oxide (NiO) alone.

It may be added also that no effect is produced by using an acidified solution of nickel salt, or a solution of ammonium hydrate, individually. The hydrogen dioxide used was a commercial 20 volume preparation.

* There is an important advantage of rapid filtration, on which I have never seen any stress laid, that I remember. It is this: Most precipitates are soluble in water, although not appreciably soluble in the liquid in which precipitation takes place. When filtration is very slow, the water used for washing, in going through the precipitate, has time to dissolve an appreciable quantity of it, while, with rapid filtration, water passes through so quickly that it displaces the solution held by the precipitate, but has *not time* to dissolve an appreciable quantity. This, combined with more thorough washing, insures greater accuracy.

NOTICES OF BOOKS.

The Manual of Colours and Dye-Wares: their Properties, Applications, Valuation, Impurities, and Sophistications. For the Use of Dyers, Printers, Drysalters, Brokers, &c. Second Edition, revised and greatly enlarged. By J. W. Slater. London : Crosby Lockwood and Co.

The increased attention which is being given in this country to technological training and its appliances is very apparent in the department of the tinctorial arts. The work before us, which has now reached its second edition, has been so far extended and modified, in accordance with the vast changes which have occurred in the arts of dyeing, printing, &c , within the last few years, that it may be regarded as an independent treatise, and is consequently entitled to a somewhat closer examination than can be usually awarded to reprints. In the present, as in the former edition, the author takes up a strictly defined subject — a survey of the colours, mordants, alterants, and other drugs used in the tinctorial arts. These bodies, partly of natural and partly of artificial production, are now so numerous that a book of reference like the present is urgently needed. There are, or have been, it is supposed, some seven hundred colours in the market derived from coal-tar alone, and "the cry is still they come." In addition, are all the roots, barks, woods, fruits, and flowers used in the tinctorial arts. There are, therefore, few men, however wide their experience, who can retain in their memories the origin, uses, appearances, and possible impurities of such a number of substances. Hence a work like the present is urgently needed.

As regards the alterations and additions which have been made in the present edition, we find that certain oversights have been rectified, the descriptions of many substances formerly of great importance, but now almost superseded, have been abridged, and on the other hand a great number of new colours and other agents which have lately come into practical use are now duly noticed. We need scarcely wonder if a few omissions have here occurred, among which we may notice ethylene blue and "white paste." But upon the whole the newest resources of the dyer and printer are noticed with completeness, accuracy, and clearness.

On the subject of adulteration and other tricks of trade the author says little. He gives, indeed, very full descriptions of the appearance which natural dye-wares, &c., ought to present if sound and of good quality. He furnishes the simplest and most practical methods both for the detection of impurities and for ascertaining the comparative value of different samples. But he holds the opinion that the artificial colours "as obtained from dealers of repute, from their accredited agents, and from respectable drysalters," are generally free from impurities, whether intentionally added or derived from defective ways of working and imperfect purification. This is quite correct. The vulgar outcry that all aniline and other coal-tar colours contain arsenic has very little foundation in sober fact. Many of these colours do not involve in their manufacture the use of any arsenical materials at all: from others it is totally eliminated. Even magenta is now made without the use of either arsenic or mercury.

The author in his preface calls attention to the extraordinar confusion which prevails in the nomenclature of

dye-wares, both natural and artificial. Certain French and Belgian dyers have lately thought fit to give turmeric the wholly unnecessary and irrational name of "terra merita." The Americans have dubbed red-woods of good quality "hypernic," and an astringent extract of the Canadian hemlock tree "tamarac," which certain English dyers take to be a corruption of turmeric. But it is amongst the new artificial colours that the greatest want of a reformed nomenclature is felt. As the author remarks—"One and the same substance is sold under different names, and in return, bodies chemically and practically distinct are confounded under the same name." We have no hesitation in saying that for the smaller dyers who buy only small quantities at a time, and are often supplied by middle-men rather than by the makers or their representatives, this modern Babel is a greater evil than sophistication. The author has done no little to clear up this confusion by giving under each colour the names by which it is sometimes known. But he does not profess to have fully accomplished his object. Indeed to do this would be the work of a life-time: it would be necessary to go round the civilised world, obtaining from every maker and dealer samples of all his products, and then ascertaining by analysis and by practical tests which of these colours were identical and which distinct. Unfortunately, dyers will buy colours without learning the exact manner of their use, or even without knowing whether they belong to the "azo" or the phthaleine group, &c. The natural result is a reaction under the influence of which they mistrust all novelties.

A prominent feature of the book when it first appeared was the large proportion of strictly original matter it contained. This matter, as far as dye-wares are concerned which are still in general use, has been retained and, where practicable, improved. The articles on logwood, myrobalans, lac, and many others may be said to have become classical, having been very extensively copied into other publications and journals. Practical dyers, &c., were in general favourably impressed with the first edition, and will doubtless welcome the work in its improved form, the more as there is no other work in the language which covers precisely the same ground. To technological students preparing for examinations in dyeing and printing it will prove exceedingly useful.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 24, June 12, 1882.

Characters and Functions of the Double Salts formed by Fusion.—MM. Berthelot and Ilosvay.—A thermo-chemical paper. The authors show that the double salts in question play an important part in a number of reactions and transformations effected in the dry way. Amongst others they mention the crystallisations of barium and strontium sulphate in the midst of their double sulphates. Barium carbonate crystallises also at the expense of the fusible double carbonates which enclose it.

Remarks on the Use of Zinc-Coke Elements in Electrolysis.—M. Berthelot.—A zinc-carbon element cannot be regarded as equivalent to a zinc-platinum element in the calculation of the quantities of heat developed by the reactions, which give rise to the voltaic current. The heat liberated by the attack of the zinc and the acid is not alone in the zinc-carbon element. The coke exerts, under these circumstances, peculiar and complicated reactions, absorbing hydrogen and oxygen, and intervening both by its pure carbon and by the foreign matters incorporated in its mass.

Certain Explosive Alloys of Zinc and of the Platinum Metals.—H. Sainte-Claire Deville and H. Debray.—This investigation, as far as the osmides are concerned, was nearly completed before the death of Sainte-Claire Deville, and has since been concluded by M. Debray. Osmium is the only one of the platinum metals which does not retain zinc when its alloy with a large excess of zinc is treated with an acid capable of dissolving this metal. The others retain obstinately about 10 to 12 per cent, and the metals insoluble in *aqua regia* (rhodium, iridium, and ruthenium), remain in the state of peculiar products, without metallic lustre, which seem to be an allotropic modification of the true alloys. It is impossible to comminute the osmides by mechanical action. A triple alloy of osmium, iridium, and zinc, if heated to about 300°, takes fire suddenly, almost with explosion, diffusing fumes of zinc and of osmic acid.

The Law according to which the Electromotive Force of a Magneto-Electric Machine varies as a Function of the Resistance of the Exterior Circuit.—Marcel Deprez.—The author has been struck with the fact that the electromotive force developed in the ring of dynamo-electric machines not only does not increase infinitely with the intensity of the currents which traverse the inducing electro-magnets, but finally diminishes very notably when the current produced increases more and more. Hence he has been led to think that the electromotive force developed in the ring of a magneto-electric machine, of which the magnetic field is constituted by a permanent magnet, is not constant, as has always been admitted hitherto, but is a function of the intensity of the current itself developed in the ring. In proportion as the intensity of the current traversing the ring increases, the wires of the ring cut the lines of force of the magnetic field comprised between the polar pieces and the ring at an angle differing more and more from a right angle, which is the angle corresponding to the maximum electromotive force. The only means of minimising within certain limits the defect inherent in dynamo-electric machines, consists in the use of very powerful inducers, surrounded with a moderate quantity of wire and of brushes capable of adjustment.

Oscillations of the Plane of Polarisation by the Discharge of a Battery. Simultaneity of Electric and Optic Phenomena.—E. Bichat and R. Blondlot.—Between a polariser and an extinction analyser a transparent body is placed in a coil of long and fine wire, which is connected with the inner and outer coatings of a battery. In the circuit there is introduced a universal discharger which permits the discharge to be produced when the difference of potential is sufficient. At the moment of each discharge the eye placed before the analyser detects a bright re-appearance of light, which shows that the plane of polarisation has been deflected.

Decomposition of Salts by Matters in Fusion.—A. Ditte.—The decomposition of calcium phosphates by matters in fusion is effected like the splitting up of salts by water or by other bodies liquid at ordinary temperatures, and it gives rise to equilibria quite of the same order. These properties belong also to analogous compounds, containing, in place of phosphorus, arsenic or vanadium.

Mechanism of Putrid Fermentation and the Resulting Alkaloids.—A. Gautier and A. Etard.—Putrid fermentation breaks up the albumenoid molecule by a process of simple hydratation. It is resolved under the influence of bacteria into two principal parts; the one, A, relatively stable, which forms the nucleus to which M. Schützenberger has given the general formula—

$$C_n H_{2n} - 4N_2O_2,$$

whence are derived the gluco-proteines, and subsequently the leucines. The other portion, B, unstable, is resolved

into ammonia and carbonic acid, and into ammonia and the formic, acetic, and oxalic acids. The existence of indol and the pyridic and hydro-pyridic bases among the products derived from the albumenoids by putrefactive hydratation compels us to admit for several of the radicles of the proteic molecule the connections of nitrogen and carbon, which characterise the homologous series of C_5NH_3 and of C_5NH_7.

Action of Heat upon a Solution of Acid Nickel Sulphate in Presence of Sulphuretted Hydrogen.—H. Baubigny. The author concludes that both for acid and neutral solutions, when the respective proportion of the weights of the acid and the metal remain constant, the precipitation of nickel is so much the more complete as the solution is more dilute. Whatever may be the proportion of the two volumes, liquid and gaseous, the precipitation increases with time.

The Decomposing Action which Certain Organic Matters Exert upon Oxygenated Water, with Reference to a Memoir by MM. Paul Bert and P. Regnard.—M. Béchamp.—The author proposes the law that whilst organised matter, the organs, or organic tissues, can disengage the oxygen of hydrogen peroxide, the proximate principles isolated from them do not possess this property.

Zeitschrift für Analytische Chemie.
Vol. xx., Part 4.

Determination of the Permeability of Soils and Building Materials.—H. Fleck.—The author rejects the aspiration process. He presses air through the soils introduced into a cylinder and made to settle as compactly as possible by tapping the sides. He finds that the times in which equal quantities of air stream out, the height of the strata of soil being equal, are inversely proportional to the height of the manometer. For equal speeds of equal quantities of air the resistances are directly proportional to the strata of soil.

Detection of Magnesia in Limestone.—M. Pichard.—Magnesia is quickly detected by its alkaline reaction. If the pulverised stone does not at once react upon red litmus paper, a portion is heated on platinum foil at the spirit-lamp to a temperature below dull redness. Pure limestone (calc-spar) remains unchanged, but if 1-1000th magnesia is present an alkaline reaction appears. The natural magnesium silicates have an alkaline reaction, whilst those of aluminium, potassium, sodium, and calcium are perfectly neutral.

Technical Examination of Glasses.—Max Müller.—The author applies the known blowpipe reactions. Lead in glass or enamel is detected by heating for a minute or two a bead of the sample fused to the end of a small glass rod. Glass free from lead shows no change. Specimens containing much lead blacken and the bead becomes opaque. Green cupriferous glass, if heated in the reduction-flame, is coloured in parts an intense purple-red. The simultaneous presence of lead masks this reaction. If a fragment which is to be tested for copper or gold is heated in a glass tube, and if both are drawn out a little while soft, the colour due to gold remains unchanged, whilst red copper-glass becomes perfectly colourless.

Determination of Sodium Ferrocyanide in Soda.—G. Lunge.—The author proposes to treat the lye with carbonic acid in order to precipitate the iron combined with sodium sulphide, to filter, evaporate to dryness, ignite strongly, and determine the ferric oxide in the residue.

Commercial Examination of Tallow at Paris.—The sample is first dissolved in chloroform, when gelatinous matters, fragments of skins, calcium phosphate of lime, and other non-fatty matters remain undissolved. The French stearine makers take 44° as the lowest permissible melting-point for tallow. In order to determine oleine and stearine portions are saponified, the soda-soap is decomposed with sulphuric acid, and the fatty acids set free are examined for their point of congelation.

Vol. xxi., Part 1, 1882.

Determination of the Ammonia capable of being Split off from the Amides in the Extracts of Plants.—E. Schulze.—An extensive reply to A. Morgen's criticism on the author's method of determining such ammonia (*Zeitschrift für Anal. Chemie*, xx., p. 37).

Studies on Argentous Oxide.—Dr. W. Pillitz.—The author shows that this supposed compound, Ag_4O, is a variable mixture of metallic silver, metallic antimony, and silver oxide.

Contributions to the Analysis of Wine.—Dr. J. Nessler and Dr. M. Barth.—The authors communicate the results of their experience on the determination of extractive matter in wine; on a modification of Neubauer's test for glucose (potato-sugar) in wines, and on the optical behaviour of pure and of sweetened wines; on the detection of free tartaric acid in wines, and on the determination of citric acid in wines. Some of these processes we shall notice at length.

Volumetric Determination of Nitrogen.—A. Bernthsen.—Already noticed.

Contributions to the Chemistry of Tobacco.—R. Kissling.—The author treats in this memoir on the determination of nicotine. He criticises the processes of Henry and Boutron-Charlard, of Schlösing, Wittstein, Kosutany, Dragendorff, Nessler, and Liecke, and proposes then the following method:—The tobacco, if in the unmanufactured state, is first freed from ribs, cut up, dried for one to two hours at 50° to 60°, and lastly reduced to a coarse but uniform powder; 20 grms. of this powder are carefully saturated with 10 c.c. of a dilute alcoholic solution of soda (6 grms. of caustic soda dissolved in 40 c.c. of water and mixed with 60 c.c. of alcohol at 95 per cent). This operation is performed with a pestle and spatula in a roomy porcelain capsule. The tobacco, which is then in the state of a moderately moist but not coherent powder, is put in a suitable packet of filter-paper and extracted with ether. For this purpose a simple extraction-tube is most suitable, as proposed by Tollens. Its wider part, connected with the reflux condenser, must be 35 c.m. in length, and the flask containing about 100 c.c. of ether must be large enough to hold 400 c.c. The paper packet is best made by coiling a slip of filter-paper, 25 to 30 c.m. in length and 10 c.m. in breadth, upon a piece of glass tube 2 c.m. in outside diameter, closing the paper tube at one end, and then introducing it into a second and longer glass tube, of such a length that some difficulty is felt in sliding it up and down. After drawing out the inner glass tube the paper is easily filled. Care must be taken that the tobacco lies everywhere equally compact and not too loose, so that no channels may be formed during extraction. This is easily effected by filling in the tobacco gradually, and frequently tapping the side of the tube. The top of the packet is finally depressed a little, and the apparatus is so fixed that the condensed ether may drop into this depression. In two or, at most, three hours the tobacco is exhausted. The ether is then cautiously distilled off, but not completely; the residue is mixed with 50 c.c. of a very dilute solution of soda (4 parts caustic soda in 1000 of water), and submitted to distillation in a current of steam. To prevent any portion of the liquid being carried over by spirting, the inner end of the exit-tube is surrounded with a double cage of wire gauze, fixed so as not to touch the end of the tube. The distillation is conducted energetically, and so that at the end only about 25 c.c. of liquid may remain in the flask. To prevent frothing over, the steam should not be introduced until the liquid has been boiling for a few minutes. Each 100 c.c. of the distillate should be collected separately, and titrated with sulphuric acid, using

rosolic acid as indicator. Only in case of very strong tobaccos it is needful to distil off more than 400 c.c.

Determination of Sulphur in Pyrites.—F. Boeckmann.—Already noticed.

Crystal Analysis.—O. Lehmann.—The author describes a microscope well adapted for observing the growth of crystals.

Spectral Analysis of Phosphorescent Light.—W. Crookes.—From the CHEMICAL NEWS.

Electric Conductivity as a Means of Ascertaining the Purity of Oils and Tissues.—L. Palmieri.—The author has observed that the electric conductivity of the oils is notably different. By means of a special bifilar electrometer, which he calls a diagometer, he utilises this principle for the examination of commercial oils.

Determination of the Difference of the Specific Gravities of Two Liquids.—W. Dittmar.—From the CHEMICAL NEWS.

Determination of Ash in Flour.—C. Weigelt.—Ten grms. of the sample are carbonised in a spacious platinum capsule, which is readily effected in less than ten minutes. The charred mass is then broken up with a platinum spatula into fragments the size of a pea, and transferred to a middle-sized platinum crucible. If any carbon adheres to the sides of the capsule it is easily incinerated, and may then be added to the bulk. Over the open crucible is turned a cylinder of mica, wide enough to leave an interval of 2 to 3 m.m. between its inside and the outside of the crucible, about half the height of which is within the cylinder. A common Bunsen burner effects the complete incineration of the carbon in six to eight hours at a low red heat.

Apparatus for Collecting and Measuring Nitrogen in its Volumetric Determination.—Paul Jeserich.—This apparatus does not differ from that described some time ago by Hugo Schiff.

Steam Apparatus Combined with Körting's Steam-jet Blast.—W. Thörner.

Small Steam-jet Blast for Laboratory Purposes.—W. Thörner.

Determination of the Vapour-Tension of Substances easily Volatilised.—W. Thörner.

An Extraction-Apparatus.—E. Thorn.

A Gas Lamp for the Production of High Temperatures.—R. Muencke.—These memoirs require the accompanying illustrations.

Closing-Fluid in Orsat's Apparatus for the Analysis of Smoke Gases.—M. Hagemann.—The author recommends mercury in preference to water, which latter may allow of errors as high as 2 per cent.

Indicators for Alkalimetry and Acidimetry.—The compiler mentions nitrophenol, proposed by H. W. Langbeck in the CHEMICAL NEWS; phenacetoline, recommended by Paul Degener; tetra-hydro-ellagic acid, suggested by J. Oser and W. Kalmann; phenol-phthaleine and tropeoline.

Development of Sulphuretted Hydrogen.—P. Casamajor.—From the CHEMICAL NEWS.

Absorption-Spectra of the Non-Metals and their Compounds.—C. Gänge.—The particulars are not given.

Detection of Ozone.—R. Böttger.—Paper saturated with perfectly neutral gold chloride is coloured violet by ozone, and is said not to be affected by nitrous acid.

The Determination of Caustic Alkalies in Presence of Alkaline Carbonates and Sulphides.—E. A. Grete.—From *Liebig's Annalen*.

Sodium Tungstate as a Reagent for Baryta.—Contrary to the statements of Anthon and Sonstadt not only neutral and ammoniacal solutions of baryta and lime, but those of baryta, are precipitated by this reagent. If the solution is strongly acidified with acetic acid, baryta alone is thrown down by sodium tungstate, while lime and magnesia remain in solution.

Behaviour of Dolomite with Acetic Acid.—K. Haushofer.—The constituents of dolomite are dissolved even at low temperatures by acetic acid, whether dilute or concentrated, in such proportions that an approximate separation of dolomite from calcite in this manner becomes impossible.

The Reducing Action of Potassium-Ferrous Oxalate.—J. M. Eder.—This reductive agent is effective, not merely in alkaline and neutral, but in acid solutions. It completely reduces platinum chloride and platinum potassio-chloride to the metallic state. Silver chloride, iodide, and bromide are reduced slowly in the cold, but quickly if heated, as is also mercuric chloride. Prussian blue, when recently precipitated, is instantly reduced.

Method for the Quantitative Determination of Ferrous Oxide along with Ferric Oxide in Presence of Organic Acids and Cane-Sugar.—J. M. Eder.—The solution, which must not be strongly acid, is mixed with an excess of neutral potassium oxalate and silver nitrate. After a few minutes, tartaric acid is added in sufficient quantity to prevent the precipitation of ferric oxide, and the liquid is then supersaturated with ammonia. The presence of ammonium chloride promotes the coagulation of the precipitate, which is then washed with water containing ammonium chloride and ammonia. From the quantity of silver obtained the ferrous oxide is calculated. Direct sunlight must be avoided, and the beakers, &c., may be coated with black paper. The process is only applicable in the absence of those organic bodies which are able to reduce silver salts in the cold.

Volumetric Determination of Ferrous Oxide in Hydrochloric Solution by Potassium Permanganate.—C. Zimmermann.—The presence of a manganous salt entirely removes the perturbing action of the hydrochloric acid. The author employs a solution of manganous sulphate containing about 200 grms. per litre. The addition of 20 c.c. of this solution enables us to obtain results which not only agree among themselves, but with the figures obtained by titration in a sulphuric solution and by the gravimetric process.

Direct Determination of Alumina in Presence of Ferric Oxide.—E. Donath.—The solution of alumina and ferric oxide, which should not exceed 100 c.c., is mixed with ammonia until the free acid is chiefly neutralised. He then adds a concentrated solution of hyposulphite to reduce the ferric oxide to the ferrous condition. The solution thus prepared is slowly poured into a boiling ammoniacal solution of potassium cyanide, the volume of which is at least double that of the solution of alumina and iron. The clear greenish yellow liquid thus obtained, after being heated for a short time, is cooled quickly and completely by setting the beaker in cold water, and is then acidified with hydrochloric acid. The alumina is then precipitated with ammonium carbonate; the precipitate is allowed to settle, collected on a filter, and washed with boiling water. The alumina appears nearly white if the proportion of iron is relatively small, and if the separation of iron cyanides has been avoided by working expeditiously. If the precipitate has a dirty yellowish colour it is digested along with the filter in dilute hydrochloric acid (1 : 4). The iron cyanides remain insoluble, whilst the alumina is dissolved, and is re-precipitated from the filtrate in the known manner.

Solubility of Prussian Blue and Turnbull's Blue.—W. Gintl.—The recent precipitates dissolve in a moderate excess of acid at a gentle heat, and in larger quantities in the cold. The faintly yellow solutions are precipitated by water. The author thinks it not improbable that Prussian blue and Turnbull's blue are identical.

Separation of Nickel and Cobalt.—G. Delvaux.—Already inserted under *Comptes Rendus* (xcii., p. 723).

Solubility of Mercurous Chloride in Mercuric Nitrate.—E. Drechsel.—Calomel in a solution of mercuric nitrate dissolves with gentle heat, forming mercuric chloride and mercurous nitrate.

Separation of Silver from Lead.—E. Donath.—The nitric solution of the two metals is mixed in a beaker, or a large porcelain crucible, with 4 to 5 c.c. of pure glycerine, supersaturated with ammonia, and mixed with 10 to 15 c.c. of concentrated soda-lye. The clear liquid thus obtained is heated, and boiled for three to five minutes; the formation of a silver deposit on the sides is prevented by stirring with a glass rod. When cold the reduced silver is filtered off, washed with boiling water, with warm dilute acetic acid, and again with hot water. The acetic acid in the filtrate is neutralised, and the lead thrown down with sulphuretted hydrogen. The separation of silver from lead is also practicable in presence of copper and bismuth, as the oxides of these metals are also soluble in glyceric alkalies.

Determination of Copper.—E. A. Grete.—The author titrates with potassium xanthogenate, a method already proposed by Schwarz.

Norwegium.—Tellef Dahll.—Already noticed.

Separation of Tungsten from Antimony, Arsenic, and Iron.—A. Cobenzl.—The finely-powdered substance is digested for five to six days with strong nitric acid, occasionally adding hydrochloric acid. The solution, together with the yellow tungstic acid, is placed in a capsule and evaporated to dryness on the water-bath. The residue is dissolved in very dilute nitric acid and again evaporated to dryness, the operation being repeated three times. The final residue is treated on the boiling-water-bath with very dilute nitric acid and a little tartaric acid, filtered, and the residue of tungstic acid and insoluble silicates and silica is washed with boiling-water slightly soured with nitric acid. The tungstic acid is easily separated from the silicates and the silica by treatment with very dilute ammonia. The ammoniacal solution when evaporated down and ignited yields pure tungstic acid. Arsenic, antimony, and iron are determined by known methods in the filtrate free from tungsten.

Separation of Tin from Arsenic and Antimony.—F. W. Clarke.—This paper consists of unfavourable criticisms upon Clarke's method.

The Electrolytic Determination of Metals.—An illustrated memoir.

Volumetric Determination of Fluorine.—S. Penfield.—From the *American Chemical Journal*.

Determination of Sulphur in Carboniferous Substances.—A. Kollert.—The sample is heated to redness in a porcelain tube 25 m.m. in width in a gaseous current consisting of 3 volumes of hydrogen and 1 volume carbonic acid. The sulphur is quickly converted into sulphuretted hydrogen without any oxidation. The gas thus obtained is passed first into a flask and then into a solution of silver nitrate faintly acidified with nitric acid. Phosphorus and arsenic do not interfere even when present in large quantity.

Precipitation of Ammonium Phospho-molybdate in Presence of the Salts of Organic Acids.—J. W. Mallet.—From the *American Chemical Journal*.

A Reaction of Tartaric Acid.—H. J. H. Fenton.—From the CHEMICAL NEWS.

Detection of Chloral Hydrate.—F. Ogston.—Yellow ammonium sulphide gives with moderately concentrated solutions of chloral hydrate an orange colouration gradually passing into brown on prolonged standing. Finally an orange-coloured precipitate appears. Butyl and so-called chroton-chloral give the same reaction.

Behaviour of Arsenic Acid with Sugar.—A solution of sugar mixed with a solution of free arsenic acid and let stand for some hours takes a rose colour, which passes into a more purple red. Lactose, grape sugar, and mannite give the same reaction, whilst starch, gum, and the sugar of liquorice are inert. Arseniates and arsenious acid do not produce the reaction.

The Compounds of Starch and Dextrine with Free Iodine.—S. U. Pickering.—From the CHEMICAL NEWS.

Determination of the Vapour Density in the Barometer Tube.—Ch. A. Bell and F. L. Tud.—From the *Journal of the Chemical Society*.

Determination of Actual Glycerine in Aqueous Solutions.—Two methods are described, that of Morawski (*Journal für Prakt. Chemie*), and that of Muter (*Analyst*). The compiler considers the latter very satisfactory.

Reduction of Alkaline Solutions of Copper Oxide by Non-Saccharine Matter.—J. H. Tucker.—From the CHEMICAL NEWS.

Volumetric Determination of Tartaric, Malic, and Citric Acid.—F.W. Clarke.—The author in a preliminary communication proposes to titrate with potassium permanganate as in the case of oxalic acid.

Determination of the Temporary Hardness of a Water.—V. Wartha.—Already noticed.

Determination of Carbon in Water.—A. Dupré and H. W. Hake.—From the *Journal of the Chemical Society*.

MISCELLANEOUS.

A Warning.—Chemists are warned against an impostor who falsely represents himself to be a brother of Dr. Emerson Reynolds, F.R.S., of Dublin University. He nominally seeks employment, but instances have occurred in which he has succeeded in obtaining money.

University College, Bristol.—We have great pleasure in bringing before our readers an earnest appeal made by Professor Silvanus P. Thompson on behalf of the physical laboratory of this Institution, which is at present unprovided with the apparatus for conducting exact experiment and original research. As we are informed, many of "the precise modern appliances of optical, acoustical, magnetic, and electric science are conspicuous by their absence." Students are not wanting, sufficient room is being provided and will be rendered available in the course of the present year. We need scarcely add that in Mr. Thompson the physical department possesses a most able, learned, and zealous professor. But all these advantages are for the present nullified by the want of the necessary apparatus. Under these circumstances Professor Thompson is endeavouring to raise a fund of £1000 to furnish the most essential requisites for the physical laboratory. We cordially second his appeal, and we trust that the friends of scientific education will not allow the University College of Bristol to remain so far behind kindred institutions in Manchester, Leeds, Liverpool, Birmingham, and Nottingham. We may add that since this effort was begun by Professor Thompson several very valuable contributions have been promised, but that further contributions or donations of apparatus would be most thankfully received.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Magnesia-Alum.—Is the native magnesia-alum (Pickeringite) employed as a raw material in any chemical industry; that is to say, has it a commercial value, and for what purpose?—J. L. W.

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THE CHEMICAL NEWS.

VOL. XLVI. No. 1181.

REVISION OF THE ATOMIC WEIGHT OF ALUMINUM.

By J. W. MALLET, F.R.S.,
Professor of Chemistry in the University of Virginia.

(Continued from vol. xlv., p. 283.)

Second Series of Experiments.

Preparation and Purification of Aluminum Bromide.—Aluminum bromide was prepared by the action of liquid bromine upon metallic aluminum of commerce, and was afterwards carefully purified. The first action is so violent that without special precaution the process involves some danger. In a first attempt a lump of aluminum weighing 15 to 20 grms. was dropped into a long-necked flask containing a considerable quantity of bromine. There was little action for a few moments, but as soon as it began vivid combustion took place, torrents of bromine vapour were driven forth, and after the flask had cooled the surplus metal was found to have been completely fused and had nearly melted its way through the glass.

By the following arrangement the bromide was prepared in large quantity and without any trouble. About 50 c.c. of bromine was placed in a large untubulated retort of hard Bohemian glass, the neck of the vessel standing vertically upwards, and an elongated piece of ingot aluminum, the upper end of which was firmly tied with aluminum wire to a glass rod, was cautiously dipped into the liquid and withdrawn as soon as violent action began. By alternately lowering and raising the glass rod the lower end of the metal was immersed in the bromine at intervals short enough to keep up the temperature of the latter and make the action practically continuous, while there was no actual ignition, and but little bromine vapour was lost. As soon as a considerable portion of this bromine had become converted into aluminum bromide the further action became manageable. The remainder of the main quantity of metal to be treated was now at once added in lumps of 10 to 20 grms. each; a long tube funnel with a glass stop-cock near the upper end was introduced into the neck of the retort, and liquid bromine was allowed to drip in at just such a rate as to keep up steady but not inconveniently violent action, taking care to keep the metal always covered. When the pieces of metal had nearly disappeared the supply of bromine was stopped, about 30 grms. more of aluminum was added in filings, the contents of the retort were digested for four hours at about 230° C., and the fluid portion was then decanted off from the insoluble residue into another (tubulated) retort. Most of the silicon was left undissolved as a brown amorphous powder. Most of the iron was converted into ferric bromide, which, during the continued heating, was in part broken up, leaving ferrous bromide instead. A little copper derived from one sample only of the aluminum used, was of course converted into bromide also.

More than a kilogramme of crude aluminum bromide being thus prepared, it was purified by repeated fractional distillations at carefully regulated temperature, using as a receiver in each case the retort to be next employed, and adding each time, except the last, a few grammes of aluminum filings. About a sixth of the whole amount was each time first distilled off and rejected as liable to contain silicon bromide, a little of this compound actually occurring in the earlier distillations; and another sixth was left behind, in order to retain the iron, which was separated with greater difficulty. After five distillations the bromide was obtained perfectly colourless, and boiling steadily at 263·3° C. under 747 m.m. pressure. Specimens were dissolved in water, and carefully examined for iron, silicon, copper, and other conceivable impurities, but none could be found. As an additional precaution, the last distillation was effected in a slow stream of pure nitrogen, so as to avoid any formation of oxide or oxy-bromide of aluminum, the propriety of this being suggested by Berthelot's recent results* as to the thermic relations of aluminum to oxygen and the haloids, and the distillate was collected in three successive portions, the results of whose analysis will be separately given further on; they go to show that these three portions were sensibly identical. The individual specimens of pure bromide required were collected in little tubes of thin hard glass, previously closed in at one end, carefully dried, and sealed at the other as soon as the tube was nearly filled, the fused bromide having been introduced through a miniature tube funnel to avoid smearing the upper end of the collecting tube, and a new, perfectly dry funnel used each time. The weight of each collecting tube had been taken beforehand, and the piece of glass drawn off in sealing being washed, dried, and weighed, the weight of the sealed tube itself was known, the difference between this and the total weight of tube and contents giving the amount of bromide.

Experiments to determine the amount of bromide in this compound by precipitation with a silver solution have the advantage over those of Dumas, above quoted, upon the chloride that, as Stas has shown,† silver bromide practically does not share with the chloride of this metal the slight solubility in the exactly neutralised liquid from which precipitation has been effected which renders difficult an exact determination of the amount of silver needed. Pursuing in general the course so carefully examined by Stas, the following were the details of the method employed.

Preparation of Pure Metallic Silver.—Pure metallic silver was prepared by dissolving in nitric acid nearly pure silver already on hand, diluting largely, precipitating with pure hydrochloric acid, digesting the precipitate with aqua regia, washing thoroughly, and reducing the purified chloride in the liquid way with sodium hydrate (from metallic sodium) and invert-sugar (from perfectly pure and well crystallised cane-sugar boiled with dilute hydrochloric acid). The metal, after having been carefully tested, was fused by a jet of purified hydrogen mixed with rather less oxygen than necessary for perfect combustion. To avoid the necessity for any cutting up afterwards with steel tools, the pulverulent metal was divided into a number of little lots of various weight, and these were supported upon the surface of little blocks made by compressing pure sugar charcoal (from cane-sugar quite free from heavy metals) made into a paste with pure cane-sugar syrup and gradually drying and heating to redness‡. The fused silver thus obtained was examined for occluded oxygen, following the method of Dumas§ in his recent experiments. It was supported upon a thin layer of pure lime in a hard glass tube, and heated to moderate redness in a Sprengel vacuum. The amount of oxygen given off was less than that obtained by Dumas, doubtless owing to the fact that his silver was fused under nitre and borax, while mine was, as just stated, melted on a surface of carbon with no flux. He obtained at the rate of 57 c.c. of oxygen (for 0° C. and 766 m.m.) per kilogramme of silver, and in other experiments, prolonging notably the time of fusion, as much as 158 c.c. and 174 c.c. I obtained but 34·63 c.c. per kilogramme, and in another experiment made by Mr. Santos, then a student in this Laboratory, the silver having been fused upon ordinary wood charcoal, but 30·12 c.c. was given off. All the silver used in the

* *Bulletin de la Société Chimique de Paris*, 20 Mars, 1879, p. 263.

† *Comptes Rendus*, 73, 993. *Annales de Chimie et de Physique*, (5), 3, 289.

‡ This form of support had the advantage that if any particles of carbon should be mechanically enclosed in the silver they would be readily seen on solution of the latter in nitric acid.

§ *Comptes Rendus*, 86, 65. *Chem. Centralblatt*, 27 Feb., 1878, S. 138.

atomic weight determinations was, in separate portions, heated in the Sprengel vacuum as long as any gas was expelled, and, having been treated with pure hydrochloric acid to remove any possibly adhering particles of lime, the granules were finally washed with pure water, dried, and kept for use in a glass stoppered bottle. An approximate calculation having been made of the quantity of silver which would be required to precipitate each of the specimens of aluminum bromide, an amount less than this by something under a decigramme was dissolved in nitric acid in a strong flask closed with a stopper, which was carefully opened when cold, and the contents were somewhat further diluted with water. The amount of specially purified nitric acid used was apportioned so as to leave the smallest possible excess after solution of the metal.

Precipitation of Silver Bromide—Details of Method used.—To avoid the danger of losing aluminum bromide when it was brought in contact with water, the action being quite violent and attended with dispersion of white fumes, each one of the sealed thin glass tubes containing the bromide was, when the time came for using it, cautiously marked with transverse scratches at intervals of about half-an-inch by means of a writing-diamond, and a strong glass bottle with a very well ground stopper having had a sufficient quantity of pure water placed at the bottom, the tube was broken across at the uppermost scratch, above the surface of the bromide, the empty point was dropped into the bottle, and the rest of the tube carefully lowered by means of a loose fitting spiral of platinum wire held sideways, so as to rest by the closed end on the bottom of the bottle without allowing the water to reach the bromide until the stopper had been inserted and tied down. By now gently inclining the bottle the water was brought very gradually into contact with the aluminum bromide, without dangerously violent action and without possibility of loss.

As soon as solution was complete and the bottle had cooled down, the stopper was removed, any liquid adhering to it washed back into the bottle, and a stout glass rod with square end was used to gently crush the tube to small fragments, as otherwise its contents could not have been brought fairly into contact with the silver solution, since the interior of the tube would have become plugged up with silver bromide. The scratches previously made upon the glass rendered it easy to break it up without any splashing, and the rod was then well washed with pure water allowed to run directly into the bottle. The silver nitrate solution destined for this particular specimen was now washed out of the flask in which it had been shortly before prepared into the bottle containing the bromide, the stopper was again inserted, and the bottle was vigorously shaken as in the usual Gay-Lussac silver assay. The precipitation of the bromide was completed with a very carefully adjusted solution of silver nitrate, containing 1 milligramme of silver per cubic centimetre, and delivered from a burette* reading clearly to $\frac{1}{20}$th c.c. The correspondence in capacity of the burette and measuring flask used was well ascertained. It was at first intended to use, for some at least of the experiments, *an excess* of silver, filter off the silver bromide formed, and determine silver in the filtrate by Volhard's method† with a standard solution of sulpho-cyanate; but this plan was abandoned as less simple, and probably requiring further investigation in regard to inherent sources or error and limits of accuracy. The completion of the reaction was therefore ascertained simply by very cautious addition of the standard silver solution until all trace of turbidity ceased, verifying the result by counter test with a drop of very dilute solution of potassium bromide. By letting the bottle stand for a little while after each addition of silver solution and shaking, and then tilting it to one side so as to bring the upper portton of the liquid above the line it had before occupied on the glass, letting the new drop fall gently in, an exceedingly slight cloud was easily seen.

It should be added that the silver globules and the tubes of aluminum bromide, after final cleansing and drying, were handled only with forceps, so as to avoid any risk of traces of chlorides being taken up from the fingers, and due attention was given to the freedom of the laboratory atmosphere from hydrochloric acid or chlorine in other volatile forms.

Direct Results of Second Series of Experiments.—The results of the experiments made in this way were—

A.—Aluminum bromide from first portion of last distillate.

	$AlBr_3$.		Ag for Precipitation.
I.—	6·0024 grms.	required	7·2793 grms.
II.—	8·6492 ,,	,,	10·4897 ,,
III.—	3·1808 ,,	,,	3·8573 ,,

B.—Aluminum bromide from second portion of last distillate.

IV.—	6·9617 grms.	required	8·4429 grms.
V.—	11·2041 ,,	,,	13·5897 ,,
VI.—	3·7621 ,,	,,	4·5624 ,,
VII.—	5·2842 ,,	,,	6·4085 ,,
VIII.—	9·7338 ,,	,,	11·8047 ,,

C.—Aluminum bromide from third portion of last distillate.

IX.—	9·3515 grms.	required	11·3424 grms.
X.—	4·4426 ,,	,,	5·3877 ,,
XI.—	5·2750 ,,	,,	6·3975 ,,

(To be continued.

* This burette was simply drawn down to proper bore at the bottom, and the flow of the liquid was regulated by the admission of air through a well-ground stop-cock at the top.

† Fresenius's *Zeitschrift für Analyt. Chemie*, 18ter Jahrg., 2tes u. 3tes Heft., S. 271.

NOTE ON DIDYMIUM.

By B. BRAUNER.

In the *Comptes Rendus* (xciv., p. 1528, June 5, 1882; see Chemical News, vol. xlv., p. 273), M. Clève published a note on a new metal from cerite, which he calls Diβ. This metal is less basic than lanthanum, but more so than didymium.

In a paper read before the Imperial Academy of Vienna on October 6, 1881, I have treated the same subject, but I have postponed the publication of the part concerning the new element of cerite until my experiments should be more advanced (see *Anzeiger der Kaiserl. Akademie der Wissenschaften*, of October 6, 1881, and of June 9, 1882.

The communication made by M. Clève permits me now to lay before the Academy the first results of my experiments, with which I was engaged for three years.

I found that the sulphate of lanthanum, purified by repeated crystallisations, can be split up into two earths on treating the oxide by a solution of ammonium nitrate. The atomic weight of the more basic (oxide of lanthanum) is 138·3 to 138·8, and that of the less basic about 140·2.

On treating didymium oxide which did not contain any lanthanum by ammonium nitrate, I could extract an earth which forms colourless salts, and the atomic weight of which was 140·6. The atomic weight of the remaining didymium was 142·5; but after repeated fractional precipitations a product was obtained at last having an atomic weight of 146·6.

In the spark spectrum of different fractions obtained on decomposing impure didymia I found lines, not belonging to any earth found in cerite, the spectra of which are known up to the present time.

I explained all these phenomena by the presence of a fourth element in cerite, which is, no doubt, identical with M. Clève's Diβ.

On purifying carefully new quantities of didymium, and especially on removing the more basic and the less basic fractions than didymium, I found for the atomic weight of didymium the number Di = 145·4 (O = 16, S = 32·074).

Using the same process for the purification of didymium, which gave formerly the atomic weight 146·6, I succeeded in separating another earth with a higher atomic weight than 154: the portion remaining after this purification gave a didymium of an atomic weight of 145·4. I consider this number as coming nearest of all to the true atomic weight of this element.

The more basic liquids obtained after the precipitation of pure didymia (which liquids were free from lanthanum) contained a mixture of didymium with an earth, which lowered the atomic weight of didymium as far as 143·3.

It is seen from the above experiments that the ordinary didymium is a mixture of at least three elements. The one is true didymium (Di = 145·4), the other (Diβ of Clève) is more basic than didymium, and its atomic weight is about 141; the third, with a higher atomic weight, is less basic than didymium (probably samarium).

The object of the above communication is not to discuss priority with the Swedish investigator, whose beautiful researches on the rare earths mark a new epoch in Science; I only intend to show that I have made observations on a new earth in cerite, independently of M. Clève.

The observations were made in Professor Roscoe's laboratory.—*Comptes Rendus*, xciv., p. 1718·19, June 26, 1882.)

ACTION OF SULPHURETTED HYDROGEN UPON NICKEL SULPHATE IN ACETIC SOLUTION.

By M. H. BAUBIGNY.

If we add acetic acid to an aqueous solution of neutral nickel sulphate, which is then saturated with sulphuretted hydrogen at 0°, and left in a closed vessel at the ordinary temperature, the action of the sulphuretted hydrogen upon the nickel sulphate is retarded, and may even be annulled.

Thus in a solution containing 0·200 grm. neutral sulphate to 140 c.c. of liquid acidulated with 3 grms. acetic acid, after standing for twenty-four hours between 12° and 16°, the sulphuretted hydrogen had not determined any precipitate. Not until some days later there appeared on the side of the vessel some very fine black grains, which increased very slowly, and became the origin of a crystalline conglomerate. The mixture was left thus for ten months, exposed to variations of temperature from 6° to 34°, but the precipitation was still incomplete, and the liquid retained 0 005 grm. nickel sulphate. But a neutral solution of nickel sulphate made of the same proportions of sulphate and water and saturated with sulphuretted hydrogen, after a month's exposure to the temperature of the atmosphere, contained merely a weight of sulphate lower than 0·001 grm. The action of the acetic acid is thus manifest. It may be even reduced one-half, that is, to 1 per cent with reference to the water without the precipitate appearing at the end of twenty-four hours, the other conditions remaining the same. If the concentration of the metallic solution is increased the results change.

If we operate with a solution containing for the same volume of liquid 140 c.c., and acidulated to 1 per cent with acetic acid a weight of 1·1 grm. neutral nickel sulphate in place of 0·200 grm., at the end of twenty-four hours the precipitate is already very notable, and it continues to increase very rapidly. After four days' exposure to temperatures between 12° and 16° 0·305 of the sulphate, or more than 27 per cent of the quantity employed, has been converted into sulphide.

If the same metallic solution is mixed with 3 grms. of acetic acid the formation of the sulphide is a little less rapid, but it still begins in a comparatively short time. It is only on adding a much larger quantity of acetic acid that the formation of the sulphide is retarded or arrested.

To annul the action of hydrogen sulphide upon nickel sulphate in solution there must be added quantities of acetic acid so much the greater as the proportion of metallic salt is higher. It has been previously shown that the nickel sulphate is decomposed in the cold by hydrogen sulphide, whence it appears that this rule is in harmony with that of the author's first note, in which he has established that in order to understand why an acetic solution of nickel acetate is not at once precipitated by the action of sulphuretted hydrogen, regard must be had to the proportions of acetic acid and nickel oxide present. From this action of acetic acid the author has deduced a method for the preparation (? separation) of nickel and zinc in the state of sulphates.

Though in the cold acetic acid retards or hinders the action of sulphuretted hydrogen upon nickel sulphate in solution, at a high temperature in a closed vessel, *e.g.*, at 100°, its action is nil.

It is found that a solution of 0·200 grm. of the nickel salt in 140 c.c. of water and mixed with 3 grms. acetic acid begins to take a slight black tint if it is kept for three hours at 40°, whilst at 20° it only gives an appreciable quantity of sulphide after the lapse of several days. At 100° the precipitation is almost complete after three hours, the liquid retaining then less than 0·001 grm. of sulphate. It is even observed that with a solution containing 1·1 grm. sulphate in 140 c.c. of water acidified with a proportionally increased quantity of acetic acid, after the lapse of three or four hours at 100°, the weight of sulphate still in solution does not exceed 0·006 to 0·007 grm. These are substantially the same results as those obtained with an aqueous solution of neutral sulphate heated to 100°.

Experiment proves that the proportion of acetic acid may even be increased beyond the quantity necessary to annul the action of the hydrogen sulphide in the cold without having any effect in heat. Thus 0·200 grm. nickel sulphate dissolved in 140 c.c. of a liquid saturated at 0° with sulphuretted hydrogen and containing about 25 per cent of acetic acid are precipitated as sulphide after four hours' action at 100° the liquid only retaining a weight of sulphate less than 0·0005 grm.

It may therefore be said that for nickel sulphate in an aqueous solution acidulated with acetic acid everything takes place in heat, in presence of hydrogen sulphide and in a closed vessel, as if the solution contained merely the neutral sulphate.

The author will show that from this observation may be derived a method of separating nickel and iron in the state of sulphates. The details will be given on a future occasion.—*Comptes Rendus.*

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London, for the Month ending June 30th, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital Medical Officer of Health for Islington.

To the Right Honourable the President of the Local Government Board.

July 3rd, 1882.

Sir,—We submit herewith the results of our analyses of the 188 samples of water collected by us during the month of June, on the days and at the times indicated, r om the mains of the seven London water companies aking their supply from the Thames and the Lea.

Of these 188 samples, 25 were from the mains of the New River Company, 26 were from the mains of the East London Company, 24 were from the mains of the Chelsea Water Company, 26 were from the mains of the West Middlesex Company, 26 were from the mains of the Lambeth Water Company, 26 were from the mains of the Grand Junction Company, and 26 were from the mains of the Southwark and Vauxhall Company. The whole were found to be well filtered, clear, and bright.

In Table I. we have recorded the analyses in detail of samples, one taken daily from June 2nd to June 30th inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

It will be seen that during the past month the condition of the waters, not only in respect to entire freedom from turbidity, but also in respect to colour, state of aëration, and freedom from excess of organic matter, was unexceptionable. The average proportion of organic carbon found in the 25 samples of water examined for this constituent amounted to 0·108 part in 100,000 parts of water, corresponding to less than one-fifth of a grain of organic matter per gallon.

We have the honour to remain, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ON THE DETERMINATION OF REVERTED PHOSPHATES.*

By THOMAS S. GLADDING, A.M.

In an investigation on the subject of reverted phosphoric acid the first question that arises is, What is meant by this term? The curious phenomenon of a decrease in the amount of soluble phosphate in a superphosphate, and its reversion into a form insoluble in water, but soluble in the organic salts of ammonia, in weak acids, and other reagents, has been attributed to several different causes.

According to the most common explanation† it is due to the gradual interaction between the soluble or monocalcic phosphate formed in the manufacture, and the still undecomposed tricalcic phosphate of the original rock, this reaction resulting in the formation of the intermediate compound dicalcic phosphate.

Again, it has been noticed that this reversion is especially large when the amounts of iron and alumina present are considerable, and in such cases it has been attributed‡ to the formation of phosphates of iron and alumina having the solvent properties specified above.

Again, from experiments in our own laboratory it has been found that this reversion is very noticeable in acid phosphates which, after treatment with sulphuric acid, have been mixed with natural phosphates containing large amounts of carbonate of lime. The reaction that takes place between the monocalcic phosphate and carbonate of lime probably results in the formation of either the dicalcic or tricalcic phosphate. This latter salt, though insoluble in water, is readily taken up, on account of its fine state of division, by the reagents used for the estimation of reverted phosphates.

From these different explanations of the character of reverted phosphate it is evident that the term is not capable of a strict chemical definition. It may consist, in any given case, of one or of several chemical compounds. The best definition that can be given is the general one condensed into the name itself. Reverted phosphates are those which, originally insoluble, but having been made soluble, have reverted or returned to the insoluble condition. They must now, however, be looked upon as—

(1.) Just over the border line that separates the soluble from the insoluble, lying very close to the soluble, and being brought back by a slight addition to the solvent power of water; and as—

(2.) Widely separated and different in solubility from the insoluble form which they originally possessed. Like the flats lying just above the river's edge, they must be wholly covered by a slight rise in the water that affects the banks but little.

The object of the inquiry here described has been to establish the above distinctions, and to find a method of separation that shall in the actual analysis recognise them as nearly as possible. The course pursued has been that followed in similar inquiries:—

I. An examination of the solubility of the different natural phosphates used in the manufacture of superphosphates.
II. An examination of the solubility of the different chemical compounds of which reverted phosphates have been found to consist; and—
III. An attempt based upon the results of these two inquiries to find the best method of separating these two classes.

In the examination of the natural phosphates five different forms were taken as typical of all. These were—

1. *Apatite*, as type of the nearly pure tricalcic form in its most insoluble condition.
2. *South Carolina Rock*, containing, besides tricalcic phosphate, phosphates of iron and alumina, and carbonate of lime.
3. *Bone Ash*, the great organic source of phosphate.
4. *Navassa Rock*, typical on account of its large per. centage of iron and alumina; and finally—
5. *Curaçao Phosphate*, as type of the island phosphates, notable for their peculiar mechanical condition and greater solubility in the organic salts of ammonia.

In examining the solubility of these natural phosphates attention was first given to the effect of different relative proportions of phosphate and solvent. The standard method of Fresenius, Luck, and Neubauer* was followed, using 50 c.c. of citrate of ammonia solution, of sp. gr. 1·09, and made as nearly neutral as possible; time, thirty minutes; temp., 35° C. Two series of experiments were made. In the first, 1 grm. of substance was taken; in the second, 1-10th of a grm.

	Series I. P_2O_5 dissolved.	Series II. P_2O_5 dissolved.
Apatite	0·40 per cent.	1·54 per cent.
S. Carolina rock	2·00 ,,	6·60 ,,
Bone ash	2·60 ,,	8·30 ,,
Navassa	2·65 ,,	10·10 ,,
Curaçao	4·40 ,,	16·00 ,,

Comparing these tables, we see at once the fact that has been commented upon very frequently of late by German chemists as regards superphosphates, and to which special attention has been called within a few months by a printed letter of Dr. S. W. Johnson, in the case of Curaçao phosphate, namely, that the percentage of phosphate dissolved increases very largely with the increase of solvent, or, what is the same, the decrease of substance taken for analysis. These tables show that this is true not only of reverted phosphates as found by the former, nor of Curaçao phosphate as shown by the latter, but also of all natural phosphates, including even

* *American Chemical Journal*, vol. iv., No. 2. Read before the American Chemical Society, March 17, 1882.
† *Zeit. für Analyt. Chem.*, x., Fresenius.
‡ *Zeit. für Analyt. Chem.*, xix, Z. Meyer.

* *Zeit. für Analyt. Chem.*, x.

the difficultly soluble apatite. This fact has a very important bearing upon the error involved in the determination of reverted phosphoric acid by this method, *i.e.*, an error as regards the strict separation of the reverted phosphates from the insoluble phosphates. Thus, supposing five superphosphates after the extraction of the soluble to contain no reverted phosphate, but to contain 10 per cent of the above raw phosphates respectively, corresponding to about 3 per cent of insoluble phosphoric acid, the citrate would attack these raw phosphates, and instead of the error being 0·04, 0·20, 0·26, 0·26, and 0·44 per cent, as would naturally be supposed from Series I., it would in reality be 0·15, 0·66, 0·83, 1·01, and 1·60 per cent, as shown by Series II. Thus the superphosphates would be reported as containing these latter amounts of reverted phosphoric acid, when in fact they contained none whatever.

This same fact of increased solvent power obtained by increasing the amount of solvent salt was shown to be true also of oxalate of ammonia, by treating 2 grms. of Navassa rock and Curaçao phosphate with 1, 5, and 10 grms. of the salt dissolved in 100 c.c. of water, at a temperature of 100° C. for thirty minutes.

SERIES III.

	1 grm.	5 grms.	10 grms.
Navassa, P_2O_5 dis...	2·20	8·75	12·15
Curaçao, ,, ,, ..	2·50	12·30	17·60

The influence of increase of temperature upon the amount of rock dissolved was shown by treating 1 grm. of the different phosphates with 100 c.c. of water containing 4 grms. of oxalate at 20° C. and at 100° C.

SERIES IV.

	Apatite.	S. Car. Rock.	Bone Ash.	Navassa.	Curacao.
At 20° C., P_2O_5 dis.—	0·36 p.c.	2·25 p.c.	2·72 p.c.	2·85 p.c.	5·51 p.c.
At 100° C., P_2O_5 dis.—	2·16 p.c.	5·80 p.c.	8·78 p.c.	9·40 p.c.	15·30 p.c.

In performing the above experiments at 100° C. a strong odour of evolved ammonia was observed, and it was also found that the filtrates were decidedly acid in reaction. The importance of this and its bearing upon the subject will be better seen further on.

The results thus far given show very clearly the cause of much of the confusion that has arisen over the determination of reverted phosphates. This lies in the great facility with which the citrate and oxalate solutions attack the insoluble phosphate, especially when the proportion of solvent is increased or when the temperature of digestion is raised. Many chemists have been led by these difficulties to seek a better method. The suggestion has frequently been made that a weak or dilute acid be employed as a substitute for the organic salts of ammonia. Thus Grupe and Tollens* recommend the use of a ¼ per cent citric acid solution. The solvent power of this acid of ¼ per cent, also of oxalic acid of ¼ per cent and $\frac{1}{10}$ per cent, also of hydrochloric acid of $\frac{1}{100}$ normal strength, upon the natural phosphates, was examined. 100 c.c. of each of the above solvents were taken; the temperature of digestion was 40° C., time one hour. One grm. was taken with each acid, and in addition also $\frac{1}{10}$th of a grm. with the citric acid of ¼ per cent.

SERIES V.

Supposing a fertiliser to contain 10 per cent of insoluble rock, the citric acid would make the reverted phosphoric acid 0·27 per cent, 1·14 per cent, 1·18 per cent, 1·40 per cent, 1·98 per cent respectively in excess of the actual amount present. The excess thus introduced would be considerably greater than that caused by the solvent action of the citrate of ammonia solution (*vide* Series II.) and

* *Berichte der Deutsch. Chem. Gesellschaft*, xjv., 754.

Acid employed:—

	Citric, ¼ per cent. 1 grm.	Citric, ¼ per cent. 1-10 grm.	Oxalic, ¼ per cent. 1 grm.	Oxalic, 1-10 per ct. 1 grm.	HCl, 1-100 normal. 1 grm.
Apatite, P_2O_5 dis.—	0·74 p.c.	2·70 p.c.	3·20 p.c.	1·08 p.c.	2·56 p.c.
S. Car. rock, P_2O_5 dis.—	2·80 p.c.	11·40 p.c.	8·75 p.c.	2·68 p.c.	4·25 p.c.
Bone ash, P_2O_5 dis.—	3·80 p.c.	11·80 p.c.	9·23 p.c.	4·15 p.c.	3·85 p.c.
Navassa, P_2O_5 dis.—	3·30 p.c.	14·00 p.c.	9·96 p.c.	3·50 p.c.	4·15 p.c.
Curaçao, P_2O_5 dis.—	4·20 p.c.	19·80 p.c.	9·12 p.c.	4·00 p.c.	3·35 p.c.

the claim made for the citric acid solution by Grupe and Tollens, that it dissolves nearly the same amount of phosphate from different quantities of substance taken for analysis, shown to be wholly unfounded as regards its action on raw phosphates. (Compare columns 1 and 2 above).

The action of the different solvents upon the dicalcic and tricalcic salts was next studied. These salts were obtained by precipitation, and on analysis found to agree so closely with the theoretical composition as to show the admixture of traces only of other forms. After thorough washing they were mixed with about an equal weight of calcium sulphate, in order to imitate the conditions under which they are found in a superphosphate. These mixtures were then thoroughly air-dried. One grm. of each was now treated with the different solvents, already employed, for thirty minutes at a temperature of 40° C. The mixture of the dicalcic salt contained 19·20 per cent of P_2O_5, of the tricalcic salt 13·00 per cent.

SERIES VI.

Solvent.	$2CaOP_2O_5$.	$3CaOP_2O_5$.
100 c.c. ¼ per cent citric acid, P_2O_5 dis. .. .. =	10·60 p.c. 9·31 ,,	10·26 p.c.
100 c.c. $\frac{1}{10}$ per ct. oxalic acid, P_2O_5 dis.	5·32 ,,	5·10 ,,
100 c.c. $\frac{1}{100}$ normal HCl acid, P_2O_5 dis.	3·42 ,,	1·90 ,,
50 c.c. cit. of ammonia sol., P_2O_5 dis.	19·20 ,,	13·00 ,,
50 c.c. H_2O + 1 grm. oxal. ammon., P_2O_5 dis.	19·00 ,, 19·05 ,,	11·50 ,,

It will be seen from this table that the citrate solution dissolves both forms perfectly; that the citric acid, though fairly successful with the tricalcic salt, dissolves only one-half of the dicalcic salt; that the other acids, notably the mineral acid HCl, fall far below the citric in this respect. Special attention is called to the vigour of the weak solution of oxalate of ammonia. Though only 1 grm. is used it dissolves all but a trace of the dicalcic salt, and falls but little short of dissolving all the tricalcic form. In the original article of Fresenius, Luck, and Neubauer, the weak acids were discarded on account of their inability to take up the reverted phosphate. This conclusion is corroborated by these experiments, with the additional objection proved by Series V., namely, the greater extent to which they dissolve the insoluble phosphate. They found also that oxalate of ammonia solution dissolved the dicalcic phosphate equally with the citrate salt, but abandoned its use on account of the vigour with which it attacked the raw phosphates. But they employed in their published experiments a very large amount of oxalate, 6 grms. of the salt being taken. But it is here found that a much weaker solution of the oxalate is effective for dissolving the dicalcic salt. As to its solvent action upon the natural phosphates, a series of experiments proved that it was not as energetic in this respect as the citrate of ammonia so-

lution, dissolving considerably less than the latter. On account of the many advantages possessed by an oxalate of ammonia solution over the citrite solution—(1) as regards ease of preparing a perfectly uniform neutral solution, (2) as to the greater facility of filtering and washing, and many others—many chemists urged and secured its adoption at the Cincinnati convention of agricultural chemists of 1881. But further experiments, to be described later, reluctantly compelled the conclusion that it cannot supersede the citrate of ammonia solution.

A series of experiments were now made upon a sample of acid phosphate, in order to compare the results obtained by the different methods, and to throw light, if possible, upon the causes of discrepancy. A sample made from Navassa rock was chosen on account of the large amount of reverted phosphate usually present in this class of fertilisers. The total phosphoric acid in the sample was 17·00 per cent, the soluble was 5·00 per cent, leaving 12·00 per cent. of reverted and insoluble. After thoroughly washing out the soluble, one grm. was treated with 50 c.c. of citrate of ammonia solution, and the directions of Fresenius carefully followed. Another grm. was treated in exactly the same way, using, however, as a solvent 50 c.c. of water containing in solution one grm. of oxalate of ammonia. The following results were obtained:—

Series VII.

	P_2O_5 dissolved.	P_2O_5 undissolved.
By citrate solution or "Washington Method"	6·10 per cent.	5·90 per cent.
By oxalate solution ..	6·15 ,,	5·85 ,,

These two methods give results that are gratifying as regards their agreement. Subsequent experiments, however, showed conclusively that both were far from the truth.

Two grms. of the same sample were now, after the extraction of the soluble phosphate, treated according to the method adopted by the agricultural chemists at Cincinnati, known as the "Cincinnati method." "The two grms. of residue were washed from the filter-paper into a beaker with 100 c.c. of water, containing in solution two grms. of oxalate of ammonia. (This is the same amount of oxalate in proportion to the quantity of substance taken as is used in the above determination). 400 c.c. of water are brought to boiling, and the beaker closely covered now introduced in the boiling water, the lamp being at the same time removed. The temperature of the liquid in the beaker will rise to about 70° C. in a few minutes, and will then slowly sink during an hour to about 40° C. The beaker is briskly rotated at intervals." Two grms. were treated in exactly the same manner, using, however, instead of the oxalate solution 100 c.c. of the citrate solution.

Series VIII.

	P_2O_5 dissolved.	P_2O_5 undissolved.
By oxalate of ammonia	8·55 per cent.	3·45 per cent.
,, citrate ,,	9·85 ,,	2·15 ,,

The point of interest connected with these results is the much larger amount of phosphoric acid dissolved by both the reagents as compared with that dissolved by them at the temperature of 35° C. continuous. This is especially the case with the citrate solution, the dissolved phosphoric acid rising from 6·10 per cent to 9·85 per cent, an increase of 3·75 per cent. This increase can be explained in two ways only: (1) Either the insoluble rock present is dissolved to this increased extent, or (2) there is a form of reverted phosphate present that is not fully taken up by either the citrate or oxalate solution at the lower temperature.

In order to ascertain if the former of these two explanations was the correct one, two separate portions of $\frac{2}{5}$ of a grm. each of Navassa rock containing 0·120 grm. P_2O_5, and corresponding to 6 per cent of insoluble phosphoric acid when calculated on 2 grms. as used in the above analysis (which is just the amount of apparently insoluble acid left in Series VII.), were rubbed to a paste in a mortar and treated each with 100 c.c. of citrate of ammonia solution, the one at a temperature of 35° C. continuous for one hour, the other at a temperature falling from 70° C. to 40° C. during an hour, as in Series VIII. The following amounts of P_2O_5 were dissolved, calculated as per cent on 2 grms.:—

Series IX.

No. 1.	Phos. acid dissolved, ..	1·16 per cent.
No. 2.	,, ,, ,,	1·59 ,,

The increase in phosphoric acid dissolved by the use of the higher temperature is found to be only 0·43 per cent. It is seen at once that this small increase cannot explain the large increase of 3·75 per cent in the case of the acid Navassa, made from the same rock.

The second of the two possible explanations, viz., the presence of a form of reverted phosphate not fully dissolved at 35° C., must therefore be the true one. The experiments already made show that this form can be neither the dicalcic nor tricalcic phosphates, as the citrate solution is a perfect solvent for these two forms at a temperature of 35° C. The only form left is the reverted phosphate of iron and alumina. A quantity of the mixed normal phosphates of iron and alumina, Fe_2O_3,P_2O_5 and Al_2O_3,P_2O_5, was now prepared by precipitation. A portion was mixed with a large quantity of calcium sulphate and dried to a powder at a temperature not exceeding 60° C. The remainder was dried at the same temperature without admixture. One grm. of the first portion containing 4 per cent of phosphoric acid was now rubbed to a paste in a mortar and then digested with 100 c.c. of the oxalate and citrate solutions, first at 35° C. and then at 70° C. to 40° C. for one hour.

Series X.

	P_2O_5 dis. at 35° C.	P_2O_5 dis. at 70° to 40° C.
Using oxalate of ammonia,	0·95 per cent.	3·20 per cent.
,, citrate ,,	1·60 ,,	4·00 ,,

One grm. of the unmixed portion containing on analysis 35·62 per cent of phosphoric acid was now treated in exactly the same way, with results as follows:—

Series XI.

	P_2O_5 dis. at 35°C.	P_2O_5 dis. at 70° to 40° C.
Using oxalate of ammonia,	11.06 per cent.	26·50 per cent.
,, citrate ,,	13·14 ,,	35·62 ,,

These two series of experiments prove the very important fact that neither the citrate nor oxalate solution will dissolve more than a small portion of the reverted phosphates of iron and alumina at the temperature of 35° C., and that even at the higher temperature of 70° C. to 40° C. the oxalate falls short of the perfect solvent power which must be required of it.

These results explain most clearly the great increase of phosphoric acid taken up in Series VIII. over that dissolved in Series VII. The acid Navassa under treatment contains a very large quantity of reverted phosphates of iron and alumina which are not dissolved at the lower temperature. They also explain why the citrate solution dissolves 1·30 per cent more than the oxalate, because of its more vigorous solvent action on these forms of reverted phosphates. One grm. of these phosphates of iron and alumina, treated with 100 c.c. of the citrate solution at a continuous temperature of 65° C. for 30 minutes, formed also a clear solution.

In order to ascertain the amount of solvent action of this method upon the different forms of raw phosphates, $\frac{1}{5}$ of a grm. of each, corresponding to about 3 to 4 per cent phosphoric acid when calculated upon 2 grms., was treated in the same manner as the above, temperature 70° C. to 40° C., using 100 c.c. citrate solution.

Series XII.

	P_2O_5 dissolved.
Apatite	0·22 per cent.
South Carolina rock	0·61 ,,
Bone Ash	—
Navassa rock ..	1·09 ,,
Curacao	2·07 ,,

Comparing this table with Series II., dividing the results there by ten, it is evident that at the higher temperature only a small increase in the amount of insoluble rock dissolved is observed.

In this connection special attention is called to one point. Notice has been called to the fact that at 100° C. the oxalate solution loses ammonia and becomes decidedly acid in reaction. A solution of neutral oxalate, immersed in boiling water for one hour in an open beaker, acquired an acid strength of $\frac{1}{8}$ per cent oxalic acid; 100 c.c. of the citrate of ammonia solution treated for an hour in the same way acquired an acid strength of 1·2 per cent citric acid. The energy with which these acid solutions attack the undecomposed rock present in a superphosphate is shown in Series V. It is on account of these facts that Fresenius uses a neutral solution of the citrate salt and adopts the low temperature of 35° C., and Luck* in a second paper dwells with great emphasis upon this point in answer to the criticisms of a French chemist. But as the higher temperature is rendered indispensable on account of the presence of phosphates of iron and alumina in the great majority of superphosphates, this loss of ammonia and consequent acidity was prevented by digestion in a flask closed with a rubber cork.

The severest criticism upon the determination of reverted phosphates as an analytical process is the fact that when different quantities of substance are taken for analysis, different results are obtained. This most exceptional experience in chemical analysis, which is without a parallel in analytical determinations, requires a most careful examination, as this has done more than all else to cast discredit upon this analytical process. And yet it seems clear that this trouble can arise from only three sources:

(1.) Either the fertiliser under treatment has so large an amount of reverted phosphate present that when a large amount is taken for analysis the citrate is unable to take it all up, but is able to do so when a smaller amount is employed, or—

(2.) The citrate is an imperfect solvent for some form of reverted phosphate that may be present, either on account of the character of the latter, or on account of the method employed failing to dissolve it completely, the error showing more clearly as larger quantities are taken for the analysis, or—

(3) The discrepancy arises from the solvent action of citrate upon the undecomposed rock present, a large percentage of this being dissolved when smaller quantities are taken (*vide* Series I. and II.). The instances given by German experimenters, in the case of fertilisers containing 25 per cent or more of phosphoric acid present as precipitated tricalcic phosphate, may be due mainly to the first of these causes. In such cases a smaller quantity must be taken, or it may be found that the higher temperature here recommended will so increase the solvent power of the citrate solution as to render this unnecessary. Whenever the phosphates of iron or alumina are present, it is evident from the experiments given that this discrepancy may be largely due to the second cause here assigned, namely, the method of the analysis, employing as it does the low temperature of 35° C. In order to ascertain whether the higher temperature of 70° C. to 40° C. will obviate the error from this second cause, 1, 2, 3, 4, and 5 grms. of the above acid Navassa were treated each with 100 c.c. of the citrate solution at this temperature, after the thorough washing out of the soluble phosphate.

(To be continued.)

* *Zeitschrift fur anal. Chem.* 14.

NOTICES OF BOOKS.

The Retrospect of Medicine, being a Half-yearly Journal containing a Retrospective View of every Discovery and Practical Improvement in the Medical Sciences. Edited by W. Braithwaite, M.D., and James Braithwaite, M.D. Vol. lxxxv., January to June, 1882. London: Simpkin, Marshall, and Co.

This volume contains the usual summary review of medical and surgical progress for the past half-year. Among the most widely-interesting portions of the contents we may mention five papers on that most complicated and difficult subject, the nature of zymotic poison. Dr. Dougall, in one of these, expresses himself as opposed to the germ theory in its ordinary form. He declares himself convinced that no living thing, germ or other, vegetable or animal, could resist the temperatures employed by Dr. Bastian in his experiments on abiogenesis. With Prof. Owen, he holds that the functions of bacteria, &c., are not malignant, but beneficent. He maintains that Pasteur, Koch, Lister, &c., "tacitly admit the physico-chemical theory, whilst ostensibly discarding it," and that "probably all, at least certainly most, of their results may be as easily explained on the physico-chemical as on the germ theory." The editor of the *Lancet*, commenting on the experiments of Rosenberger, where septicæmia was produced by the injection of virus so treated as to destroy all the bacteria present, suggests that some of them must have escaped the "cooking" process, and have survived in a condition to develop in the favourable soil of a living organism, although not in a mere culture-liquid. Dr. Harley, in a memoir on the action of germs in the production of human diseases, mentions some exceedingly interesting facts connected with the rapidity of decomposition. One case was that of a girl who had died after a few hours of illness at a "Blood manufactory" for sugar refining purposes. The body was green and putrescent within thirty-six hours of death. It is suspected that the blood of diseased horses from the knacker's yard was being employed.

No candid person will be able to read these papers without being driven to two conclusions,—the prodigious difficulty of some of the questions with which medical science has to grapple, and secondly the utter hopelessness of their solution without experimentation upon animals.

We note an instance of a man suffering from irritation in the feet plainly caused by his boots, who ascribed the affection to the dye of his stockings. They coloured water green, *ergo* they were dyed with some poisonous substance!

Of two persons suffering from diphtheritic ophthalmia, one, a porter at Smithfield meat market, thought he had acquired the disease by contact with an acrid "sweat" on some diseased American pork. The other, a slaughterman, volunteered the statement that he had often killed diseased animals, and that few calves, "not one in ten," have perfectly healthy livers.

Prof. Semmola, of Naples, makes a novel and successful application of electrolysis in the treatment of malignant tumours.

Catechism of Modern Elementary Chemistry. By E. W. v. Volckxsom, F.C.S., Lecturer on Chemistry at Downside College, Bath. London: Kegan Paul and Co.

"The value of this work," says the author, "for candidates at matriculation of the London University cannot be overrated, as it contains the answers to all the questions which have been set at that examination for about forty years." These questions have been arranged according to the subject-matter, and under each is given the dates of the examination when it was set. It is added, somewhat naïvely,—"These dates will thus show how frequently any question has been repeated, and will therefore

indicate to students and teachers the points upon which special stress should be laid." The primary object of the work, therefore, is to enable candidates to "pass," and to gives to teachers a wrinkle in the art of "grinding" or "coaching." We recollect that a work which gave in a somewhat similar manner a list of the questions set and answers given during former years at certain examinations was somewhat severely handled by some of our contemporaries, as pointing out a way of passing through the fashionable ordeal with a minimum of labour and of knowledge. We do not endorse this censure. So long as the present utterly mistaken value is set upon "passing," we hold that teachers are perfectly justified in finding out all the weak spots through which it is possible to drive, as through an Act of Parliament, the traditional "coach and six." The more such guides are published and acted on the sooner will examinationism, like the shares of a bubble company, fall to its true value.

For the questions asked and the answers given Mr. von Volckxsom is of course in no way responsible. To one question and to its reply we must draw passing attention. It is asked: "In what points is gun-cotton analogous to gunpowder?' Had we been the unfortunate examinee we should have replied, 'Simply in being explosive, though the bodies are chemically heterologous, the one being a compound and the other a mechanical mixture.'" On turning over the page we find the accepted answer is:—"Gun-cotton is analogous to gunpowder chiefly because it contains in itself in every part of the mass the oxygen necessary for complete combustion." Now if we refer to the last edition of "Miller's Chemistry," edited by Dr. H. E. Armstrong and C. E. Groves (vol. iii., p. 649), we find the formula of tri-nitro-cellulose given as $C_6H_7(NO_3)_3O_2$. Hence it appears that even if all the nitrogen were evolved in the free state there is not oxygen enough for complete combustion, that is, for converting all the carbon into carbon dioxide, and all the hydrogen into water. But all the nitrogen is not deoxidised. At the great Stowmarket explosion in 1871 the column of smoke and vapour which was shot up into the atmosphere was plainly seen to be bordered with orange-coloured fumes. It is in virtue of this deficience of oxygen that some inventors have endeavoured to improve gun-cotton by adding to it some substance rich in oxygen, *e.g.*, a nitrate.

CORRESPONDENCE.

SUGAR ANALYSIS.

To the Editor of the Chemical News.

Sir,—In Mr. Casamajor's* exposition of the strange mistake made by Tucker in his "Sugar Analysis," in regard to the estimation of sucrose by Clerget's method, he remarks that it would have been better to have determined the effect of heating with mineral acids upon the rotatory power of commercial grape-sugar. I beg leave to call attention to the fact that this has already been done, by the same person to whom Tucker evidently refers when he speaks of "analyses of sugars containing large amounts of commercial grape-sugar having been published, &c." Prof. Wiley (*Jour. Am. Chem. Soc.*, vol. ii.) has shown that quite a considerable error is introduced by the heating of commercial starch-sugar with acid. I would also remark that I have thoroughly examined Landolt's article, to which Tucker refers, in support of his position,† and find nothing to warrant him in his statement that Landolt says that Clerget's method is inapplicable where other optically active bodies besides cane and invert sugars are present. What Landolt does say is that *the direct polarisation* gives correct results only when the solution contains no optically active substances except cane-sugar, and *in these cases* the results are *controlled by Clerget's method. I wish to point out another error in Tucker's work.* On page 285 he says—"On account of the high rotatory power of starch-sugar, a refined sugar mixed with it will show a larger percentage of cane-sugar by the saccharimeter than the true one; hence the analysis generally adds up over one hundred."

This is not the case. Mixed cane- and starch-sugars do not polarise higher than pure cane-sugars, but rather lower, if there is any difference. The highly converted starch-sugar used for mixing contains a very large percentage of dextrose, which has (after heating) a specific rotatory power of about 53 for the sodium ray, while the specific rotatory power of sucrose for the same ray is about 66. In the glucose syrups, where the percentage of the highly rotatory sugars, maltose, and dextrin is greater, the rotation is much higher. In an examination I have made of 25 samples of mixed sugars, the highest direct rotation in any sample was 93·7, the lowest 78·5, on the cane-sugar scale. This is not far from the range of the cane-sugars of commerce, certainly not higher. The highest rotation I ever found in a solid starch-sugar was 96·4 on the cane-sugar scale of a Laurent instrument, requiring 16·2 grms. pure sugar to read 100 on the scale. The glucose syrups will frequently go over 100.

I have no doubt but that the manufacturers regulate their mixtures so as to have the polarisation approximate as closely as possible to some grade of straight sugar. Such a sugar would pass inspection with such sugar chemists as Tucker, who never make an inversion, but take without question the direct reading of the polariscope for the percentage of cane-sugar—unless it should go over 100!—I am, &c.,

Chas. A. Crampton.

Ann Arbor, Mich., U.S.A.,
June 24, 1882.

FLAMELESS COMBUSTION.

To the Editor of the Chemical News.

Sir,—That combustion of hydrocarbons is to a limited extent possible without flame is well known, but that it is possible on a large scale with good results is, I think, new. The first time this fact was publicly demonstrated was at the Soirée of the Society of Chemical Industry at Owens College on the 6th inst., when, directing a gas flame on a large mass of iron wire until red-hot, I gradually turned a blast of air on until the flame totally disappeared. As the flame became smaller the temperature increased until, on its disappearance, the iron fused and ran into drops, the whole mass being intensely heated, and remaining so notwithstanding the fact that not a trace of flame could be detected in a perfectly dark room. It was evident that the highest temperature was obtained when the flame was totally absent.

As a further demonstration, proving that the combustion of the iron is not a necessary condition, the highest temperatures in the injector furnace are obtained only when the gas is burnt in the furnace without flame. It would appear that not only is flame unnecessary, but its presence may be considered a proof of imperfect combustion.

It is a matter of considerable interest whether this admits of practical application; whether the absence of flame is a universal law when the combustion of any substance takes place under the most perfect conditions.—I am, &c.,

Thos. Fletcher.

Museum Street, Warrington.

Valuation of German Yeast.—E. Geissler.—The author adds a known quantity to 100 grms. of a 10 per cent solution of sugar at 25° to 30°, and determines the carbonic acid evolved in an hour.—*Zeit. f. Anal. Chem.*

* Chemical News, vol. xlv., p. 150,

† In his letter to the Chemical News, vol. xlv., p. 86; *Jour. Prak. Chem.*, ciii., p. 4.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 25, June 19, 1882.

Reaction Current of the Electric Arc.—M. Jamin and G. Maneuvrier.—The two alternating currents in opposite directions given by Gramme's self-exciting machine are absolutely equal; consequently they do not decompose water, and a tangent compass introduced into the circuit experiences no deviation, since the contrary effects which follow at very short intervals destroy each other. This destruction of the effects is maintained if we introduce into the circuit one or more burners, provided that the two carbons are equal, identically arranged, and are equally heated. If we introduce eight to ten Bunsen elements into the circuit they give the compass, when the machine is at rest, a deviation δ, and if it is in action a deviation δ', absolutely equal to δ. This equality proves that the resistance of the wires of the machine for a current derived from an exterior source does not change, whether the machine is at rest or in action. It proves, further, that the two effects of the machine and the battery are superposed and independent of each other. If we now suppress the battery and introduce into the circuit a burner formed of two unequal carbons, the one thick and the other slender, this want of symmetry suffices to determine a permanent deviation of the compass as if a battery had been introduced. The two systems of inverse currents given by the machine cease to be equal; that which sets from the thick carbon to the thin one prevails over that in the opposite direction. Hence there results a differential current, which is shown by the compass and which is so much the more intense as the difference of thickness of the two carbons is greater.

The Reciprocal Displacements of the Halogens, and the Secondary Compounds by which it is Influenced.—M. Berthelot.—In the reciprocal displacements of the halogens as well as in the conditions almost numberless which the author has examined since the outset of his researches, the direct and inverse reactions and the equilibria remain invariably submitted to thermochemical laws.

Separation of Gallium.—Lecoq de Boisbaudran.—See p. 3.

Determination of Atmospheric Carbonic Anhydride to be Effected at Cape Horn.—A. Müntz and E. Aubin.—The authors merely describe the apparatus they have arranged for the expedition to Cape Horn.

Products of the Distillation of Resin.—A. Renard.—The yield of butyric and valerianic acids is 2 to 3 per cent of the crude essential oil obtained. The butyric acid is the isobutyric acid of Kolbe, boiling at 152° to 155°. The valerianic acid boils at 173° to 175°; its density at $+16° = 0{\cdot}941$. It presents great analogies with ordinary valerianic acid, but is clearly distinguished by its zinc salt.

Microzymas as the Cause of the Decomposition of Oxygenated Water by the Tissues of Animals and Plants.—M. Béchamp.—Reverting to the observation of Thénard that among the immediate principles of organic origin, the fibrine of the blood alone separates oxygen from hydrogen peroxide, the author undertakes to show that the power of the tissues to effect the same decomposition is due to the fact that the blood conveys its microzymas into all parts of the organism.

Various Properties of Hydrocyanic Acid.—C. Brame.—Hydrocyanic acid in vapour determines a scarcely visible turbidity in the white of egg or in a solution of albumen. Hydrocyanic acid dissolved in water precipitates abundantly pure albumen and its aqueous solution. The preservation of the bodies of animals poisoned with hydrocyanic acid is prolonged for a year. The rabbits, &c., poisoned with this acid, which figured at the Industrial and Artistic Exhibition of Tours, are still in good preservation, though they several times during the Exhibition underwent a temperature of 38°. After some months the bodies of animals injected or poisoned with hydrocyanic acid and preserved in stoppered vessels, lose all the odour of this acid, and take that of ammonium formiate, a salt which may be detected in the serous liquid. Ammonium formiate prepared directly with ammonia and formic acid gives a crystalline deliquescent matter, so that to obtain it the liquid must be evaporated over sulphuric acid with exclusion of air. In embalming with hydrocyanic acid it will be necessary to introduce into the body a small quantity of some matter which will harden on absorbing moisture (zinc chloride).

Chemical Composition of the Different Layers of a Current of Lava from Etna.—L. Ricciardi.—The author has analysed six specimens of the lava of 1669 taken at different depths of one and the same stream and in the same perpendicular plane. The only difference between the layers is in the different proportions of iron in the highest stage of oxidation.

Comparison of the Alkaline Chlorides as to their Poisonous Power and the Minimum Fatal Dose.—C. Richet.—The author has experimented with the chlorides of lithium, sodium, potassium, rubidium, and cæsium, injected subcutaneously. According to him there is in the series of the alkaline metals no relation between atomic weight and physiological activity. Rubidium, which has a high atomic weight, is much more inoffensive than sodium. Lithium, which has the lowest atomic weight of the metals, is fatal in very small doses.

Zeitschrift für Analytische Chemie.
Vol. xxi., Part 1, 1882.

Determination of Traces of Organic Matter in Potable Water.—W. L. Hiepe.—The author adds to 500 c.c. of an apparently good water 1 c.c. of a 1 per cent solution of oxalic acid and evaporates down in a glass capsule with the precautions laid down by Prof. Frankland. The residue is covered with a thin layer of calcium carbonate, scraped loose from the glass by means of a flexible steel spatula; the capsule rinsed out two or three times with calcium carbonate, and the whole introduced into a combustion-tube, which is filled up with soda lime in the usual manner, and with an asbestos plug. The end of the tube is then drawn out at the blast-lamp, so that it may plunge into a 1-per cent solution of oxalic acid. The combustion is conducted slowly till the evolution of gas ceases. The drawn-out end of the tube is broken off, rinsed in the oxalic acid, the latter distilled with alkali, and the ammonia is determined colorometrically in the distillate.

The Schulze-Tiemann Apparatus for Determining Nitric Acid in Potable Waters.—C. H. Wolff.—A modification of that figured in the sixth edition of Fresenius's "Treatise on Quantitative Analysis."

Examination of Beer.—H. Dragendorff.—An extensive memoir, describing a method for detecting the presence of bitter principles other than that of the hop.

Determination of Phosphorus in Iron and Steel.—A. E. Haswell.—The borings are covered with a 7-per cent solution of ammonio-cupric chloride in a well-corked flask, which is kept cool by being set in cold water. After digestion for twelve hours, with occasional shaking, the solution of ferrous chloride, which should be nearly free from copper, is carefully decanted off from the residue. The latter containing in addition to the spongy deposit of

copper, all the negative elements of the iron, carbon, silicon, sulphur, and phosphorus, is repeatedly washed with distilled water. The turbid washing-waters are filtered, and the filter is dried and incinerated. The residue in the flask is oxidised by the gradual addition of strong nitric acid, and finally by the application of heat. When the reaction is over it is rinsed into a capsule. The ash of the filter is then added; the solution is evaporated to dryness in the water-bath to eliminate silica, the soluble portion is filtered from the carboniferous silica, and the latter is purified by fusion with potassium-sodium carbonate, and again separated with nitric acid. The phosphoric acid in the second filtrate from the silica is precipitated by molybdic solution, and this precipitate is added to the main phosphoric precipitate. The deep blue filtrate from the carbon containing silica, which contains the main bulk of the phosphoric acid, is treated with molybdic solution in the usual manner. If the solution of molybdenum, prepared according to the formula of Lipowitz with ammonium tartrate, is used in presence of copper, the phosphoric acid is thrown down imperfectly or not at all.

Weyl's Method of Determining Carbon in Iron and Steel.—S. C. Jutsum.—From the CHEMICAL NEWS.

Determination of Silicon in Crude Iron.—T. N. Brown and P. W. Shimer.—From the CHEMICAL NEWS.

Condition of Silicon in Bessemer Steel.—L. L. De Koninck and A. Ghilain.—The particulars of this memoir are not given.

Presence of Nitrogen in Iron and Steel.—A. A. Allen.—From the CHEMICAL NEWS.

Detection of Glucose in Cane-Sugar.—P. Casamajor.—The author lixiviates the sample with a saturated solution of glucose in wood-spirit at 50 per cent, which easily takes up cane-sugar. The residue is washed with wood-spirit at 98·5 per cent, dried, and weighed.

Determination of Sugar in the Juices of the Sorghum Plant.—P. Collier.—We purpose returning to this memoir.

Determination of Chlorides in Urine.—M. Salkowski.—Volhard's process admits of direct application to the specimen, and gives satisfactory results.

Determination of Nitric and Nitrous Acids in Urine.—F. Röhmann.—The process of Schulze, which consists in liberating the nitric acid, reducing with ferrous chloride, collecting and measuring the nitric oxide formed, gives satisfactory results. For the determination of nitrous acid, Trommsdorff's process for its determination in water was somewhat modified.

Quantitative Determination of Urine.—E. Ludwig.—The urine is mixed with ammoniacal solution of silver and magnesia mixture. The precipitate, containing all the uric and phosphoric acids, is filtered off, washed with ammoniacal water, decomposed with a hot ammoniacal solution of potassium sulphide. Potassium urate is formed, and remains in solution. Filter, acidulate slightly with hydrochloric acid, and concentrate on the water-bath down to a few c.c. The uric acid which separates out on cooling is collected on a filter of glass-wool, washed with water, dried at 110°, and freed from sulphur by washing with carbon disulphide and afterwards with ether.

Approximate Detection of Phenol in Urine.—A. Cloetta and E. Schaer.

Modification of Pettenkofer's Reaction for the Bile-Acids.—E. Drechsel.—The author recommends phosphoric acid in a syrupy solution to be added, instead of sulphuric acid, to the concentrated solution of the alkaline salts of the biliary acids.

Isolation of Alkaloids.—A. H. Allen.—From the *Analyst*.

Meta-phosphoric and Hydro-ferrocyanic Acids as Reagents for Albumenoids in Urine.—The use of the former acid is due to Grigg (*British Medical Journal*). Hofmeister proposes to substitute hydro-ferrocyanic acid for the mixture of acetic acid and potassium ferrocyanide.

Poisonous Principle of Illicium religiosum.—J. F. Eykmann.—The body in question appears to be free from nitrogen.

Detection of Colchicine.—J. Hertel.—The author, after extracting the object in the usual manner, treats it again with the strongest alcohol.

Certain re-determinations of atomic weights, given at the end of this issue, have been already noticed in the CHEMICAL NEWS.

Die Chemische Industrie.
Vol. 5, No. 5.

This issue, in addition to specifications of patents, contains a long essay on the German patent law in reference to chemical industry, by Dr. Relig.

Revue des Industries et des Sciences Chimiques et Agricoles
No. 55, 1882.

Disinfection and Agricultural Utilisation of Blood (Continuation).—As the safest and most economical procedure the author recommends coagulation with ferric sulphate. The quantity of blood yielded by an ox is estimated at 20 litres, whilst a sheep yields only 2.

Purification of the Waste Waters of Manufactories (Continuation).—The authors discuss the treatment of the waste waters from wool-washing, as at Roubaix and Tourcoing. They recommend that the waters of the Espierre, the sewage river of those towns, should be impounded at a convenient place, and treated with ferric chloride in the proportion of 200 c.c. per cubic metre, and turned into a settling-tank holding 1200 cubic metres. They propose to make use of filter-presses in freeing the deposit from water.

Disinfection of Alcohol by Electrolysis (Concluded).—MM. Naudin and Schneider.

No. 56, 1882.

Phosphoric Acid in the Arable Soils of the North.—In the alkaline or neutral soils of the north bone-black and fossil phosphates give but very poor results, whilst the same manures used in the acid soils of Bretagne and the Vendée have done wonders.

Note on the Composition and Analysis of "Dégras."—F. Jean.—In the process for preparing so-called chamois leathers a considerable amount of fatty matter remains as a by-product and is sold under the name of "dégras" to curriers, who use it for rendering ordinary leathers supple.

Means of Reducing the Production-Cost of Wheat by the Judicious Use of Manures.—H. Joulie.—The author recommends the substitution of good for inferior varieties, sowing by drill instead of broadcast; greater care in the destruction of weeds; reaping in suitable weather; threshing by machinery to prevent the waste of grain; deep cultivation, which secures the plants from drought and excess of moisture; and above all the judicious management of manures.

Chemical Manures Applicable to the Sugar-Cane.—E. Riffard.—In this extensive memoir the author recognises the eminent services which M. Georges Ville has rendered to agriculture by giving an impulse to the use of chemical manures. The sugar-cane requires manures rich in phosphoric acid and in nitrogen in a state ready for assimilation. In an experiment made on these principles the yield was at the rate of 356,000 kilos. of sugar per hectare.

Cosmos Les Mondes.
No. 6, June 10, 1882.

Observations on a Paper by MM. Bartoli and Papasogli entitled "Synthesis of Several Organic Compounds by means of the Electrolysis of Water, and of Acid, Alkaline, and Alcoholic Solutions with Electrodes of Coke.—D. Tommasi.—The authors above named state in their memoir, read before the Academy of Sciences May 15th, 1882, "The combination of electric oxygen with carbon is a fact which we have observed in 1879. We are surprised to see this fact published by M. D. Tommasi (*Comptes Rendus*, 1881, p. 790)." The latter *savant* writes—"Immediately after the first memoir, published in the *Nuovo Cimente* (Série 3, vol. iii., Nov., 1880), I addressed a letter to the editor, stating that in 1879, whilst studying the electrolysis of fused ferric chloride with coke electrodes, I had observed that the positive electrode was disaggregated and resolved into dust, whilst one part of the carbon combined with the chlorine. I afterwards added that I proposed to submit to electrolysis formic acid, or a formiate, using electrodes of coke, in order to obtain new compounds richer in carbon." This letter was reproduced in several Italian journals, but MM. Bartoli and Papasogli did not think it their part to reply. Now, after the lapse of more than a year, they raise the question of priority before the Academy.

Theory of Electric Conductivity.—M. Pilleux.—The continuation of a mathematical paper, not capable of useful abstraction.

MISCELLANEOUS.

Dangerous Device in Shape of a Cigar Lighter.—The following letter to the *New York Public Ledger* should receive attention as a warning. A sample of the dangerous thing has been tested at that office:—Mr. Editor,—As I stepped from the platform of a car this morning (corner of Seventh and Filbert Streets) I came upon a motley crowd, listening to the harangue of a bright fellow, who entertained his audience somewhat after this manner, "Only five cents. I offer you, gentlemen, something entirely new—a new kind of cigar-lighter. Cut off a small piece (about the size of a pin's head), place it upon a cigar or the contents of a pipe, as I do now, apply a drop of water, and it will at once take fire. We generally use water to *put out fire*, but here I will use it to make a fire," and then, dipping the pointed open knife into the gutter, the orator touched with it the bit of cigar-lighter lying upon the tobacco, and, presto! it took fire almost immediately, and burned with an intensely yellow flame. The vendor continued, "Once kindled, the flame will not go out till your pipe is lighted. Only five cents, who'll take the next?" The writer of this "took the next," with the view of examining the contents of the vial and reporting to you. The vial (an "$\frac{1}{3}$th homœopathic vial," covered with marble paper), contained several very small sticks of the metal sodium. Little did Sir Humphrey Davy imagine when he made his brilliant discovery of the alkali-metals, that ere the close of the century one of them would be hawked about the streets to light cigarettes and pipes. Insurance men can tell a sorrowful tale of the loss of life and property caused by the household use of friction matches. But what if papa should leave within reach of the children metallic sodium, a material that must always be handled with great care, even by those best acquainted with its properties. I trust that you will give the above immediate publicity, that people throughout the country, being forewarned, may leave the "new cigar lighter" severely alone, and that our efficient Mayor may, if possible, prevent the retailing of metallic sodium in the streets of Philadelphia.—Yours, &c., R. A. Fisher, Consulting Chemist, No. 2239, St. Alban's Street.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Free Acid.—Wanted particulars of a reliable method (volumetric) of ascertaining the percentage of free acid in mother-liquors or in sulphate alumina.—Widnes.

TO CORRESPONDENTS.

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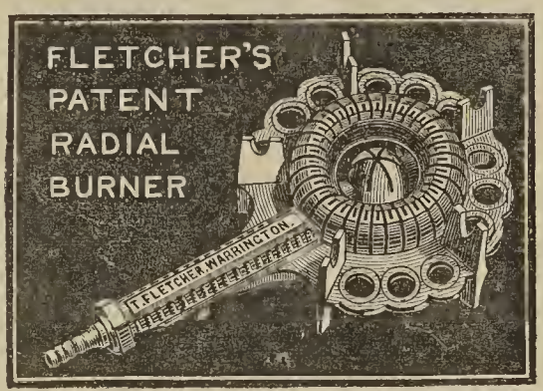

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GOLD MEDAL, INTERNATIONAL ELECTRICAL EXHIBITION, PARIS 1881.

THE CHEMICAL NEWS.

Vol. XLVI. No. 1182.

REVISION OF THE ATOMIC WEIGHT OF ALUMINUM.

By J. W. MALLET, F.R.S.,
Professor of Chemistry in the University of Virginia.

(Continued from p. 16.)

Third Series of Experiments.

Preparation of Pure Metallic Aluminum.—A further supply of pure aluminum bromide having been made as above described, it was used to prepare metallic aluminum by reduction with sodium.

With a view to render the bromide more manageable while in contact with the air, it was decided to unite it with an alkaline chloride, as the aluminum and sodium chloride is used in the ordinary process of Deville, and in order to keep down the melting-point, a mixture of both potassium and sodium chlorides was employed. The two alkaline salts were separately purified, carefully tested, and well dried in platinum vessels, mixed in the proportion of one molecule of each, the mixture fused in lots of about 250 grms. in a platinum dish over a gas furnace, poured out into another such dish standing on a block of cold iron, the thin cake gently crushed to a coarse powder while still warm in a mortar of hard glazed porcelain (from which, it was afterwards proved by examination, no silica was taken up), and the pulverised product kept until needed in a well stoppered bottle. Separate portions of the purified aluminum bromide having been in the last distillation collected in tared glass flasks and weighed, a quantity of the above mixture of alkaline chlorides was weighed off for each corresponding to 1 molecule $(K+Na)Cl$ for 1 molecule $AlBr_3$, and the flask having been heated until the bromide was fused, the potassio-sodic chloride was cautiously added. Very marked rise of temperature occurred, so that in a first attempt, using considerable quantities of the materials and mixing them abruptly, since such an effect had not been foreseen, the flask was violently cracked, and torrents of aluminum bromide vapour were driven off. This evolution of heat is interesting as evidence of chemical combination taking place, not only between two chlorides or two bromides, but between a chloride and a bromide. The fused mass was on cooling crushed to small fragments and coarse powder and preserved in a well-stoppered bottle. The precaution was not omitted of testing for any evidence of impurity derived from the flasks or mortar, but with negative result. The material thus prepared did not fume in the air, was sufficiently slow in taking up atmospheric moisture to be managed without difficulty, and fused on re-heating to about 130° C. The sodium to be used in decomposing it was in large ingots, which when needed were wiped to remove naphtha, the outer crust cut off with a knife, the large pieces roughly weighed, and the proper quantity rapidly cut up into small fragments without again moistening with naphtha.

The great difficulty in the way of obtaining pure metallic aluminum consists in obtaining crucibles of suitable material, especially such as shall not yield either iron or silicon. M. Tissier* seems to have been more fortunate than I in the use of carbon vessels. The crucibles of hard carbon which I had on hand, purchased in Germany, contained both the above-named impurities, which were taken up in no small quantity by the aluminum; and I failed in sundry attempts to make crucibles of purer carbon, or to use this substance as a lining, the carbon either burning away, crumbling up, or permitting the fused materials to pass through its pores or through cracks in the mass. I at last succeeded in adapting to my purpose alumina itself, sufficiently cemented together by sodium aluminate. I was indebted to Mr. Henry Pemberton, Vice-President of the Pennsylvania Salt Manufacturing Company at Natrona, Pennsylvania, and to Mr. W. N. Richard, of the same works, for an abundant supply of aluminum hydrate, such as is thrown down by a stream of carbon dioxide from solution of sodium aluminate in the process of making soda from cryolite. This was not absolutely free from iron, but one lot contained traces only of this metal, insufficient, as it turned out, to contaminate the aluminum to be made in contact with it. The hydrate was strongly heated in well-covered crucibles until it ceased to give off water; the alumina which was left required then to be guarded from the air, as it readily took up moisture again. All attempts to use it mixed with water and any unobjectionable cementing material to a plastic mass failed from excessive shrinkage and crumbling, but by mixing it in the dry state with dry sodium aluminate better results were obtained. The sodium aluminate had to be specially prepared, as that made (for soap boilers' use) at Natrona from cryolite contained too much iron. The dry mixture was pressed into wooden moulds, and three or four crucibles thus made having been very slowly and cautiously heated up in a gas furnace, stood fairly the necessary temperature of the reduction of aluminum, although they were very fragile. On the whole, however, it was found best to use a highly aluminous Beaufaye crucible, with a thick lining of this mixture of dry alumina and sodium aluminate well rammed in and very gradually heated. There were some failures from cracking of the crucibles or linings, and whenever the slightest contact of the metallic aluminum with the outer crucible occurred, silicon and generally iron were sure to be found in the metal. With successful prevention of this by an adequately thick and perfectly continuous lining there was much difficulty in securing a sufficiently high temperature in the interior, since the conducting power for heat of the alumina linings seemed to be quite low. This led to much loss of sodium by combustion, and but a very small yield indeed of really pure aluminum was secured. When the crucible had been heated up ready for the reduction, a small quantity of the pulverised mixture of potassium and sodium chlorides was thrown in; soon afterwards the aluminum bromide (which had been fused with the alkaline chlorides) with the proper quantity of sodium was introduced,* and as soon as the violent reaction was over a further portion of the mixed alkaline chlorides.

Only the large, well-fused globules of aluminum were picked out; these were re-fused once or twice before a blowpipe flame upon a support of alumina, to free them from any possible remains of the flux; any trace of oxide was detached by acting slightly upon the surface with pure hydrochloric acid, and the globules were then well washed with water, and dried by a gentle heat. Specimens cut from different portions of the globules were carefully tested, particularly for silicon, iron, sodium, and potassium; and a sufficient quantity of the metal for the intended experiments was found to yield no appreciable trace of impurity. The surface of the specimens to be used which had touched the cutting pliers was again cleansed by acid and water. This pure aliminum did not differ much in physical character from the ordinary metal of commerce; it seemed, however, to be somewhat whiter, was distinctly softer, and had a little higher density, the mean of three closely-agreeing determinations made at 4° C., giving the number 2·583 as referred to water at the same temperature.

* *Comptes Rendus, loc. cit.*

* Aside from the question of expense there is some advantage in using aliminum bromide for making the metal, on account of the low melting-point of the sodium bromide which is left. Carnelley's recent determinations (*Chem. Soc. Jour.*, July, 1878, pp. 279, 280) make the melting-point of sodium bromide 708° C., while that of the chloride is 772°, and that of the fluoride above 902°.

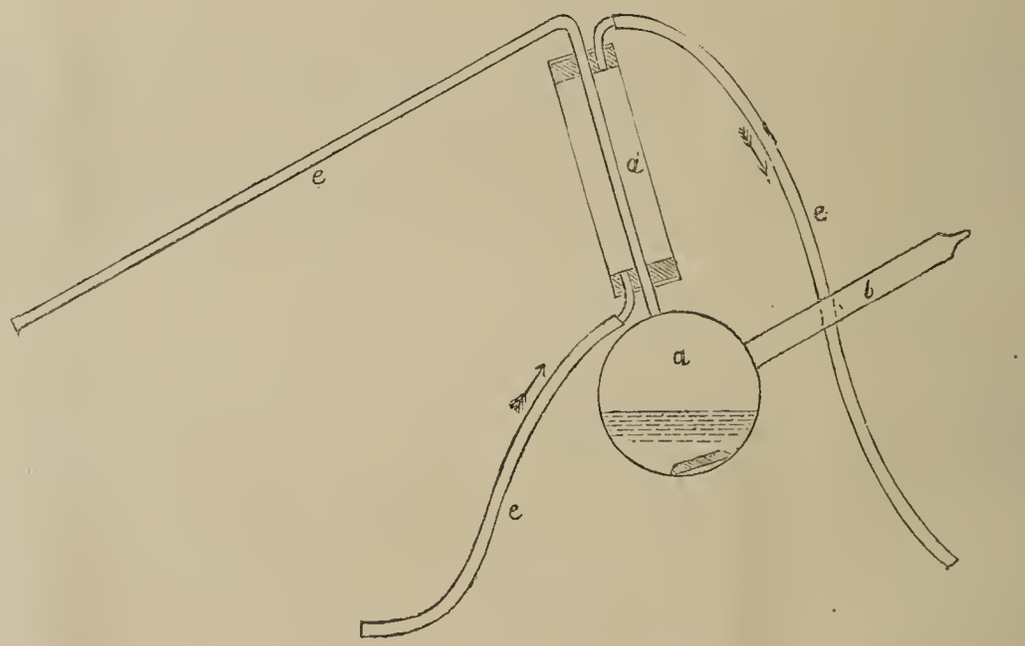
Production of Hydrogen by Aluminum, and Measurement of the Gas.—Details of Method used.—The pure metal was used for the determination of its atomic weight by acting upon a known weight of it with a strong solution of sodium hydrate and determining the amount of hydrogen evolved. The advantage of using an alkali rather than hydrochloric acid, as in Terreil's experiment above quoted, lies in the non-volatility of the former, only vapour of water having to be separated from the hydrogen, while sulphuric acid is not available on account of the resistance to its action of aluminum. In 1863 Fr. Schulze* proposed to measure the volume of hydrogen given off by the action of an alkaline solution on commercial aluminum as the means of approximately deciding on the comparative purity of different specimens. The nature of the reaction was established by preliminary experiments, which proved to me that normal sodium aluminate alone is formed, so that each atom of aluminum liberates three atoms of hydrogen. The sodium hydrate was prepared from metallic sodium, and was used in the form of a solution so strong as scarcely to lose a sensible amount of water by the passage through it of a dry gas at common temperature—such an alkaline solution, so far as strength is concerned, as would be used to absorb carbon dioxide in an organic analysis. The quantity taken for each experiment was but a few cubic centimetres, and but little beyond the exact amount required for the solution of the metal; a small excess was, however, always allowed, so that the action might not become very languid towards the end. This strong alkaline solution was prepared with water which had been boiled to expel air, and the solubility in it of hydrogen was ascertained to be so small that any correction on this account would have fallen within the limits of inevitable error, and might be safely neglected.

To secure accurate measurement of a somewhat large volume of hydrogen, two stout flasks were selected, one holding about a litre and the other about half as much, and with narrow necks of rather more than usual length; and on the necks a simple millimetre scale was marked. One of these flasks having been carefully filled with mercury and inverted over the mercurial trough, the hydrogen was collected in it, such a quantity of aluminum being used in each experiment as previous trials had shown would yield gas enough to bring the level of the mercury within the range of the scale on the neck. To thus obtain such a volume of gas as could be accurately measured in the narrow part of the flask it was necessary to note in advance roughly the prevailing temperature and pressure, and to take advantage of a time when these were not undergoing much change. The level of the mercury having been noted on the millimetre scale, the corresponding volume was afterwards determined by calibration with mercury, weighed in portions of about half a kilogramme.

The little piece of apparatus used for the solution of the aluminum is shown in fig. 2, in which (*a*) represents a glass bulb of about 65 m.m. diameter; (*b*) a tube connected therewith, originally open at both ends, and about 12 m.m. diameter and 175 m.m. long, but afterwards reduced in length to about 100 m.m. by drawing off and sealing, as shown in the figure; (*c*) is the much smaller tube for carrying off the gas produced; (*d*) is a water jacket like that of the common Liebig's condenser, formed by a piece of larger tube surrounding the ascending limb of (*c*), and put in place before (*c*) was bent; while (*e*, *e*) represent small india-rubber tubes for circulating a current of water through (*d*).

Each experiment was made as follows: The proper quantity of strong solution of sodium hydrate, its volume

FIG. 2.



accurately measured, having been introduced into the bulb by means of a little tube funnel passed through (*b*), taking care to leave the surface of the latter clean, the aluminum (usually in a single piece of elongated shape) was passed through (*b*), held nearly horizontal, so that the metal did not slip down into the bulb, but rested 40 or 50 m.m. from it. (*b*) was now drawn off and sealed with a well-rounded end. The bulb was touched for a moment or two with the hand, so as to expel a very little air, and the outer end of the small tube (*c*) was introduced into the mercury of the trough, taking care that (*b*) was still kept in such a position as to prevent the aluminum coming in contact with the alkaline solution. After a sufficient lapse of time for the apparatus to have acquired the temperature of the room, the barometer and thermometer and the difference of level of the mercury in the trough and in (*c*) were read off;* so that, knowing the volume of alkaline solution introduced and of aluminum (the latter from its weight), calibration of the bulb and tubes after the experiment was over completed the data necessary to determine the volume of air which the apparatus contained at the beginning. The aluminum was now made to slide down into the bulb, the end of the gas-delivery tube (*c*) having been brought under the mouth of

* Fr. Schulze, *Die gasvolumetrische Analyse*, S 18, quote in Wagner, *Jahresbericht*, u. s/w., 1864, S. 23.

* All readings were of course made from a distance with the aid of a small telescope.

the measuring flask. Over-rapid evolution of hydrogen and any considerable rise of temperature was prevented, partly by tilting the bulb so that the little piece of aluminum rested against one side and exposed but a part of its surface to the action of the liquid, and partly by cooling the outside of the bulb with water; while, on the other hand, it sometimes became necessary to gently warm the liquid towards the end of the experiment. To guard against more than traces of aqueous vapour being carried away with the hydrogen, a current of ice-water was kept up through (*d*). As soon as the last of the aluminum had disappeared, leaving the liquid quite clear, (*c*) was brought up into a nearly vertical position, and the apparatus left to itself until the temperature of the room had been attained. The barometer and thermometer, height of mercury in (*c*) above that in trough, and level of mercury in neck of measuring flask (after the last traces of moisture had been removed from the hydrogen by means of a stick of caustic potash), with its height above that in trough, were now read and recorded. Lifting (*c*) straight up from the trough, the mercury in this tube was got out by running a wire up and down in it, and inverting it, the whole of the remaining space in (*a*), (*b*), and (*c*) was filled up with alkaline lye of the same strength with that already contained, this liquid being run in from a graduated burette through a slender tube funnel, and the volume used noted, so as to show how much liquid had been already present. The apparatus being now emptied, washed out, and calibrated (with water, instead of mercury, on account of the difficulty of getting the interior quite dry), the volume of gas remaining in it at the close of the experiment was had from the difference between the total capacity (to the level of the mercury in (*c*)) and the volume of the liquid which the bulb had contained at the close of the experiment, these taken together with the data for pressure and temperature.

On account of slight rise of temperature during the solution of the metal, the volume of hydrogen left in the bulb and tubes was always less than the air in the same at the beginning; and, after reduction to normal temperature and pressure, the difference had to be subtracted from the volume of gas collected in the flask.

In order to connect the weight of the aluminum with the weight of the hydrogen, the latter being obtained from its observed volume and Regnault's determination of its density, it was necessary that the weight of the metal should be absolute, or in terms of equal value with those used in Regnault's researches; hence, as has been already stated, the weights used were such as had had their real value determined, and the precaution of double weighing was applied. The quantities of metal used being small, the centre of gravity of the balance-beam was so adjusted as to give great sensitiveness.

In calculating the weight of the hydrogen from its volume, the difference in the value of the force of gravity at Paris and at the University of Virginia had to be taken into account. In view of the difference of latitude and elevation above the sea this constant is, in C.G.S. units,

For Paris	980·94
For University of Virginia	979·95

and, applying the difference in nominally normal pressure at the two places, Regnault's value for the weight of a litre of hydrogen at 0° C. and 760 m.m., 0·089578 grm., becomes 0·089488 grm.

In the experiments made in this way the only assignable cause of constant error, tending to affect in a particular direction the atomic weight reduced from them, seems to be the retention in solution of traces of hydrogen by the alkaline liquid in the bulb. The tendency of this is, of course, to make the atomic weight of aluminum appear greater than it should be, but I am satisfied that the possible extent of such error must be excessively minute, inappreciable within the limits of error of observation.

Direct Results of First Set of Third Series of Experiments.—The results obtained were as follows:—

A.—Hydrogen by volume at 0° C. and 760 m.m.

I.—0·3697	grm. of Al	gave	458·8	c.c. = 0·04106	grm. of H.
II.—0·3769	,,	,,	467·9	,, = 0·04187	,,
III.—0·3620	,,	,,	449·1	,, = 0·04019	,,
IV.—0·7579	,,	,,	941·5	,, = 0·08425	,,
V.—0·7314	,,	,,	907·9	,, = 0·08125	,,
VI.—0·7541	,,	,,	936·4	,, = 0·08380	,,

Second Set of Experiments of Third Series.—Hydrogen Collected and Weighed as Water.—Details of Method used.—As the collection and accurate measurement of larger quantities of hydrogen would be difficult from the great weight of mercury to be dealt with, while it seemed desirable to repeat these experiments with a larger amount of aluminum, an arrangement was adopted for burning the hydrogen and weighing it as water.

A bulb like that described above was used for the reaction between the aluminum and solution of the sodium hydrate, another small tube (which may be designated as (*x*)) being connected, however, with the bulb, for the purpose of sweeping out air at the beginning of the combustion and the remainder of the hydrogen at the end by a current of other gas. The gas from the delivery tube (*c*) was carried through a series of four drying tubes, containing in the former two pumice stone soaked with pure sulphuric acid of full strength, and in the other two well dried asbestos and loose woolly phosphorus pentoxide; thence it passed through a long combustion-tube, filled for the first two-fifths with pure, finely granular cupric oxide, which had been recently ignited, and for two-fifths more with turnings of electrotype copper oxidised on the surface, while the last one-fifth of its length remained at first unoccupied, to be filled later as will be described; the vapour of water being finally collected beyond this combustion-tube in a single light drying-tube of calcium chloride, one of sulphuric acid on pumice, and one of phosphorus pentoxide.

The whole of the apparatus having been put together, with the exception of the three final drying-tubes, for which at first a single unweighed calcium chloride tube was substituted, with sodium hydrate solution in the bulb, and metallic aluminum in the tube (*b*), a slow stream of carefully purified and well dried air was passed through from (*x*) for some time, while the combustion-tube was heated to low redness. Having allowed it to cool down to the temperature of the room, the stream of air from (*x*) was replaced by one of dry nitrogen; a plug of soft copper turnings with bright unoxidised surface was introduced into the further end of the combustion-tube, so as to fill up the unoccupied fifth of its length, and it was again brought to and kept at a red heat. After the nitrogen had passed through at this temperature for about twenty minutes, the three drying-tubes for the collection of the water to be formed, having been standing for some time in the balance case, were accurately weighed, and connected with the further end of the combustion-tube, the previously used and unweighed calcium chloride tube being removed. The tube (*x*) having been closed, the tube (*b*) was now tilted so as to make the aluminum slip down into the alkaline liquid, and as in the experiments already described, the rate at which the hydrogen was evolved was controlled by inclining the bulb so as to vary the extent of surface of the metal attacked, and by cooling the outside of the bulb with water.

As soon as the metal was all dissolved, nitrogen was again introduced by (*x*) to sweep out the remaining hydrogen, limiting the quantity of the former gas to such an amount as was thought necessary for this purpose. This nitrogen was then in turn replaced by pure and dry air, which was passed through the apparatus until the surface of the copper which had been reduced was reoxidised, this being done to avoid any risk of occluded hydrogen being retained, while the nitrogen had served to obviate the danger of explosion. The drying-tubes were then finally removed from the further end of the combustion-tube, and weighed after exposure to the atmosphere of the balance case long enough to permit the surface of the glass attain-

ing a constant condition. In both weighings the reduction to equivalent weights *in vacuo* was duly attended to, the weights and densities of all the materials making up the drying tubes and their contents having been previously ascertained. The last tube of the set was weighed separately, as was the last of the drying-tubes connected with the reaction bulb, and it was found that, there being no increase of weight on the part of either of them, the absorption of aqueous vapour was sensibly complete.

Although all the precautions I could think of were taken in these experiments, the well known difficulty of absolutely excluding moisture, of which every joint to the apparatus becomes a possible source, so that in ordinary organic analysis the amount of hydrogen found may be expected to come out rather above than below the truth, leads to the suspicion that such constant error as may have been involved tended in this direction, and if so that the resulting atomic weight would be made to appear somewhat too low. The extent of error from this cause, however, if it existed at all, must have been extremely small.

Direct Results of Second Set of Experiments of Third Series.—The results of these last experiments were—

B.—Hydrogen weighed as water.

I.—2·1704 grms. of Al gave 2·1661 grms. of H_2O.
II.—2·9355 ,, ,, 2·9292 ,, ,,
III.—5·2632 ,, ,, 5·2562 ,, ,,

(To be continued.)

CONCERNING PHTHALIMIDE.

By M. KUHARA,
Fellow in Chemistry, Johns Hopkins University.

In a paper on the oxidation of orththo-toluene-sulphamide* it has been shown by Remsen and Fahlberg that, when ortho-sulpho-benzoic acid is treated with phosphorus pentachloride and ammonia, it is converted into benzoic sulphinide,—

$$C_6H_4\begin{cases}CO\\SO_2\end{cases}NH.$$

It is probable that the normal chloride of the acid is first formed, and that when this is treated with ammonia the ammonium salt of sulphamine-benzoic acid is formed, which when treated with hydrochloric acid yields the sulphinide—

$$C_6H_4\begin{cases}SO_2Cl\\COCl\end{cases}+4NH_3+H_2O=$$
$$=C_6H_4\begin{cases}SO_2NH_2\\COONH^4\end{cases}+2NH_4Cl, \quad \text{and}$$

$$C_6H_4\begin{cases}SO_2NH_2\\COONH_4\end{cases}+HCl=$$
$$=C_6H_4\begin{cases}SO_2\\CO\end{cases}NH+H_2O+NH_4Cl.$$

It seemed probable from a consideration of these reactions that phthalic acid when treated in a similar way would yield phthalimide, and at the suggestion of Prof. Remsen, I have made some experiments in the direction indicated.

Phthalyl chloride was made according to the directions of Ador,† by boiling phthalic acid (1 mol.) with phosphorus pentachloride (2 mols.) and a little oxychloride. On treating this with aqueous ammonia it passed into solution, and now on adding hydrochloric acid a bulky precipitate was produced. This dissolved easily by heating; on cooling, a mixture of white scaly crystals with a minute quantity of fine needles was deposited, while on still further concentrating the mother-liquor phthalic acid crystallised out. By re-crystallising the mixture from alcohol, beautiful transparent rhombohedral crystals were obtained, and from the mother-liquors the needle-shaped crystals mentioned above were deposited. The rhombohedral crystals, which were obtained in larger quantity than the needles, were analysed:—

I. 0·2 grm. gave 14·74 c.c. N after corrections.
II. 0·196 grm. gave 14·78 c.c. N after corrections.

A substance of the formula—

$$C_6H_4\begin{cases}CO\\CO\end{cases}NH,$$

that is of the formula of phthalimide, requires 9·52 per cent N, while the quantities found correspond to 9·21 and 9·42 per cent respectively.

The substance is, however, quite distinct from phthalimide. It is soluble in cold alcohol and water, more readily in boiling alcohol and water, while phthalimide is not soluble in cold alcohol and water. It melts without decomposition when heated, and sublimes in flakes. It dissolves in concentrated sulphuric acid and water, throwing down phthalic anhydride from the solution. It melts at 192°, the imide at 230°. It gives no precipitate with silver nitrate.

From the knowledge thus far gained it seems as though this substance must be regarded as an isomeride of phthalimide. According to von Gerichten* it appears probable that phthalyl chloride is either—

$$C_6H_4\begin{cases}CCl_2\\CO\end{cases}O,$$

or a mixture of this substance with the normal chloride. If this view is correct, the formation of a substance isomeric with phthalimide might easily be accounted for. The action of ammonia upon a substance of the formula

$$C_6H_4\begin{cases}CCl_2\\CO\end{cases}O$$

might give rise to a product of the formula—

$$C_6H_4\begin{cases}C(NH)\\CO\end{cases}O,$$

which would be isomeric with phthalimide. The formation of such a substance would be exceedingly interesting and its study attractive. I regret to say that, though I made repeated efforts to get possession of more of this product, they all failed, and I was obliged to give up its study. It is strange that in the first experiment just exactly the right conditions for its formation should have been found, and that these could not again be met with.

In the subsequent experiments it was found that when phthalyl chloride is treated with ammonia and hydrochloric acid phthalic anhydride is precipitated. It was also shown that when ammonium phthalamate is treated with hydrochloric acid phthalic anhydride is precipitated. When phthalyl chloride is dissolved in ammonia and the solution concentrated to a very small volume, phthalamic acid,—

$$C_6H_4\begin{cases}COOH\\CONH_2\end{cases},$$

is deposited. This was carefully compared with phthalamic acid prepared from phthalic anhydride, according to Marignac's directions,† and the two were found to be identical.

The connection known to exist between phthalic anhydride, phthalamic acid, phthalimide, and phthalyl chloride, would then lead to the conclusion that all these bodies have a similar structure. Phthalamic acid is made from ammonium phthalate by heating, and the only equation which will represent this reaction satisfactorily is the one commonly used—

$$C_6H_4\begin{cases}COONH_4\\COONH_4\end{cases}-NH_3-H_2O=C_6H_4\begin{cases}CONH_2\\COOH\end{cases}.$$

* *American Chemical Journal*, i., 426.
† *Annalen der Chemie*, 164, 230.

* *Berichte der Deutsch. Chem. Gesell.*, 13, 417.
† *Annalen der Chemie*, 42, 219.

Further, when phthalamic acid is heated it gives off water and is converted into phthalimide:—

$$C_6H_4\begin{Bmatrix}CONH_2\\COOH\end{Bmatrix}-H_2O=C_6H_4\begin{Bmatrix}CO\\CO\end{Bmatrix}NH.$$

It is possible, of course, to conceive of the formation of the isomeric substance,—

$$C_6H_4\begin{Bmatrix}C(NH)\\CO\end{Bmatrix}O,$$

under these circumstances, but its formation does not appear probable. While, then, it is impossible to decide positively what the formula of phthalimide is, the probabilities are in favour of the one commonly accepted.

Now, when phthalyl chloride is treated with gaseous ammonia it is converted directly into phthalimide. The reaction takes place very easily, and is accompanied by a decided evolution of heat. The substance possessed all the properties of phthalimide as described by Laurent and Marignac. The yield was excellent; apparently almost quantitative. Assuming that phthalimide has the commonly accepted formula, the only way to represent this transformation of the chloride satisfactorily is by the equation—

$$C_6H_4\begin{Bmatrix}COCl\\COCl\end{Bmatrix}+3NH_3=C_6H_4\begin{Bmatrix}CO\\CO\end{Bmatrix}NH+2NH_4Cl.$$

But this leads to the view that the chloride has the normal structure, whereas, as was stated above, the experiments of von Gerichten indicate that the chloride is—

$$C_6H_4\begin{Bmatrix}CCl_2\\CO\end{Bmatrix}O.$$

It is possible that a substance isomeric with phthalimide is formed when phthalyl chloride is treated with ammonia, and that this is then converted spontaneously into the imide.

A few derivatives of phthalamic acid were made, as this substance has been but very imperfectly studied. The only salts of the acid which have hitherto been prepared are those of silver and ammonium. In order to prepare the imide it was found most convenient to pass dry ammonia into a flask containing phthalic anhydride, slightly heated. A violent reaction took place, the mass instantly melting, and then soon solidifying again. The solid mass was essentially pure imide.

To an aqueous solution of phthalimide there was added an excess of baryta water, and the two boiled together. A current of carbon dioxide was then passed through the cooled solution, the precipitated barium carbonate filtered off, and the clear filtrate concentrated. The salt does not crystallise from an aqueous solution, the latter finally becoming syrupy in consistency and remaining so even after long standing. If alcohol be added to the concentrated aqueous solution the salt is thrown down as a white amorphous powder, being entirely insoluble in alcohol. This was filtered off, dried, and analysed:—

0·1135 grm. precipitated barium salt gave 0·057 grm. $BaSO_4$.

Calculated for

$$\left(C_6H_4\begin{Bmatrix}CONH_2\\CO_2\end{Bmatrix}\right)_2Ba \quad . \quad . \quad 29{\cdot}46 \text{ per cent Ba.}$$

Found . . 29·47 „ „

Potassium Phthalamate, $C_6H_4\begin{Bmatrix}CONH_2\\COOK.\end{Bmatrix}$—This salt was prepared by the gradual addition of a very dilute solution of potassium sulphate to the solution of the barium sulphate. After filtering off the precipitated barium sulphate the solution was left to evaporate slowly over sulphuric acid. After several days very fine, silky, transparent needles crystallised out. It is easily soluble in alcohol and water. It gives off ammonia when boiled with potassium hydroxide, and hydrochloric acid throws down phthalic anhydride from its solution.

Copper phthalamate was prepared from the barium salt by precipitating with a solution of copper sulphate. It does not crystallise, but gradually separates in the form of an amorphous powder.

Phthalamic is an exceedingly weak acid, and its salts are not well characterised compounds.*—*American Chemical Journal.*

ON THE DETERMINATION OF REVERTED PHOSPHATES.*

By THOMAS S. GLADDING, A.M.

(Concluded from p. 21.

SERIES XIII.

	P_2O_5 dissolved.	P_2O_5 undissolved.
Employing 1 grm. substance	10·06 per cent.	1·94 per cent.
„ 2 „	9·85 „	2·15 „
„ 3 „	9·65 „	2·35 „
„ 4 „	9·43 „	2·57 „
„ 5 „	9·02 „	2·98 „

The very slight and uniform decrease of reverted phosphoric acid, about 0·20 per cent for each additional grm. taken, up to the 5 grms. when the increase is a trifle larger, would certainly seem to show that every source of discrepancy but the third mentioned above had been obviated. When it is observed that in the last experiment 0·451 grm. of reverted phosphoric acid is dissolved by the 100 c.c. of citrate of ammonia solution at the temperature of 70° C. to 40° C., it certainly seems that nothing further could be desired as regards vigour of action upon the reverted forms. No other solvent suggested will approach the citrate solution in this important respect, when employed at the temperature here adopted.

But as regards the third cause of discrepancy it is very different. This cause lies in the very nature of things and cannot be overcome. No reagent can be found that will dissolve the strictly reverted phosphates and not affect the undecomposed rock present. Nor is it desirable that any such reagent should be found, nor would it be just to employ it in case it were possible to find it. The whole idea upon which the determination of reverted phosphates rests is that the solvent action of the liquids of the soil is stronger than that of pure water, and is closely imitated by the solvent action of the organic salts of ammonia. Now there is a certain percentage of raw phosphates that will always be taken up by this increased solvent power, and this percentage is practically and with justice considered equal in value to and reported as reverted phosphate.

The only difficulty that now presents itself is to so fix the amount of substance taken for analysis that the solvent action of the citrate solution upon the undecomposed rock shall dissolve such a percentage of this as shall when reported as reverted phosphate be a fair equivalent of its agricultural value. This conception here stated will be best illustrated by the accompanying diagram. 2 grms. of the five forms of raw phosphates were treated with 100 c.c. of citrate of ammonia solution at a falling temperature

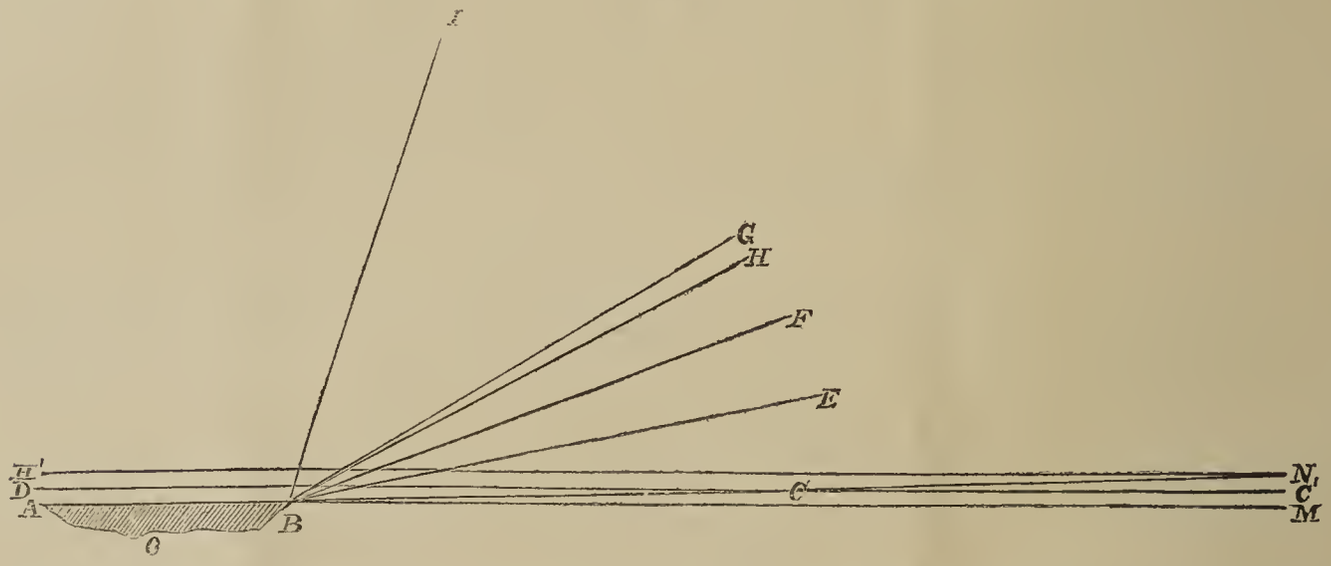
* The fusing-point of phthalic acid has been the subject of considerable discussion, the last statement bearing upon it having come from E. Ador (*Annalen der Chemie*, 164, 239). Ador says the crystallised phthalic acid melts at 213°, and the powder of the same substance at 203°. The discrepancies in the statements on record seem to be due to the fact that when the acid is heated it is partly converted into its anhydride before its fusing-point is reached. The presence of the anhydride tends to lower the fusing-point, and this is the lower the more anhydride there is formed. If the acid is heated slowly, or if it be used in the form of powder, more anhydride is formed and the fusing-point is lower. Some special experiments were made with the pure acid to test the correctness of this view. Small quantities were heated in U-tubes placed in paraffin baths at the temperature of 140° and 170°. In both cases anhydride was formed and the fusing-point of the acid considerably lowered. Under exceptional conditions the fusing-point of pure phthalic acid may be observed as high as 213°, but usually it will be found to vary considerably. To test the purity of the acid it is advisable to make the anhydride, and then crystallise this, when pure, from water.—I. REMSEN.

70° C. to 40° C. for one hour, also two grms. of the reverted phosphates of iron and alumina containing 35·62 per cent of phosphoric acid. The latter was dissolved to a clear solution.

Series XIV.

Apatite ..	Phosphoric acid dissolved,		0·60	per cent
South Carolina rock	,,	,,	2·62	,,
Bone Ash	,,	,,	3·15	,,
Navassa	,,	,,	3·75	,,
Curacao	,,	,,	7·50	,,
Reverted phos. of iron and alumina ..	,,	,,	35·62	,,

In the diagram use is again made of the figure of speech previously employed. AOB is the river bed, representing the phosphates soluble in water, completely covered by the line AM, the height of which represents the solvent power of water. The line BC represents the flats or the reverted phosphates lying just above the water, and slightly rising, since the different forms possess different degrees of solubility. The line DC' represents the solvent power of 100 c.c. of citrate of ammonia solution at the temperature 70° C. to 40° C. The lines BE, BF, BH, BG, and BI represent the banks rising at different angles, or the different raw phosphates, Curacao, Navassa, bone-ash, South Carolina rock, and



apatite here examined. These lines are all two inches in length, to represent the 2 grms. of substance taken. All of BC falls below DC or becomes soluble in the citrate solution, ¼ of BE, ⅛ of BF, $\frac{1}{11}$ of BH, $\frac{1}{10}$ of BG, and $\frac{1}{70}$ of BI, calculating from 30, 30, 36, 27, and 42 percentages of phosphoric acid present in the five samples.

Now suppose 1 grm. of the above substances be taken to 100 c.c. of citrate solution. This proportion is the same as 200 c.c. citrate solution to the 2 grms. of substance taken in the diagram. The line DC will be raised to H'N, twice as far above the surface of the water. Twice as large an amount of reverted phosphates will be taken up, viz. BN, and at the same time nearly twice as large an amount of raw phosphates as shown in the figure. Thus repeating Series XIV., using, however, 1 grm. of substance, there were dissolved as follows :—

Series XV.

Apatite ..	Phosphoric acid dissolved,		1·06	per cent
South Carolina rock	,,	,,	—	
Bone Ash	,,	,,	5·20	,,
Navassa	,,	,,	6·20	,,
Curacao	,,	,,	11·50	,,

Attention is called to the nature of Curacao phosphate as brought out in this connection. Since by successive treatments with citrate of ammonia solution, or by employing a very small quantity for analysis, as $\frac{1}{10}$ of a grm., nearly all of this can be brought into solution, many chemists regard its phosphoric acid as nearly all in the available form, and an analysis made by one chemist on the identical sample used in this work reports the presence of 18 per cent of reverted phosphoric acid. But the whole course of experiments given in this paper shows conclusively that it differs from the other raw phosphates only in degree of solubility, and is very far removed as regards this property from the true reverted forms, being, as shown in the diagram, based upon Series XIV., only ⅓ as soluble at the best as the latter, and only about twice as soluble as Navassa rock and bone-ash.

It seems almost certain from the agricultural experiments described in the last edition of Johnston's "Agricultural Chemistry," on the use of finely ground raw phosphates, that all the phosphoric acid in such phosphates becomes ultimately soluble in the soil. The division of phosphates therefore into the three forms, soluble, reverted, and insoluble, will have reference only to the time required to render them available for plant use. Supposing, in the accompanying diagram, that the solvent action of 100 c.c. of the citrate solution represents the solvent action of the liquids of the soil for a certain period of time, as *e.g.* one season, upon the forms of phosphate there represented, it is evident that all the soluble and reverted would be available the first season, that raw Curacao would all be rendered available in something over five seasons, the Navassa in eight seasons, and so on. The divisions, therefore, of soluble, reverted, and insoluble become indispensable as means of fixing commercial and agricultural values.

In conclusion, emphasis is laid upon the following points as brought out in this enquiry :—

I. While the line of division between the reverted forms and the original insoluble forms of phosphoric acid may be sharply drawn in the case of an extremely insoluble phosphate, like apatite, in the case of the more easily soluble natural phosphates the two great classes overlap, one the other. Whatever solvent therefore is used for determining reverted phosphates, the same will also dissolve a small percentage of the undecomposed phosphate that may be present; this percentage varying considerably according to the character of the insoluble phosphate. This percentage, representing as it does the comparative solubility which such insoluble phosphate possesses to the true reverted phosphates present, is justly considered as equivalent to an equal amount of the true reverted forms, and reported as such.

II. A slightly ammoniacal citrate of ammonia solution, alone of all the solvents that have been proposed, is a perfect solvent for all the forms of reverted phosphate, while at the same time not unduly dissolving the raw or insoluble phosphates present. Such a solution dissolves but a trace of the most difficult soluble form of phosphate known, viz., apatite, and dissolves the other natural phos-

phates to a greater and greater extent as they approach in character the true reverted forms.

III. Neither the "Washington method" (method of Fresenius), nor the "Cincinnati method" can be relied upon to take up all the reverted phosphates that may be present.

IV. A modification of the method of Fresenius, consisting of the use of a higher temperature for the digestion, will meet all the requirements of the case, provided that the greatest care is taken to guard against acidity of the solvent and consequent excessive solution of the insoluble phosphates present. Whether the falling temperature of 70° C. to 40° C. as here explained, or a continuous temperature of 65° C. for 30 minutes, be used, there will be but slight if any differences in the results, provided that the solution of citrate be slightly ammoniacal, and the digestion be made in a closed flask. To the use of *acid* solutions of citrate, either acid at the beginning of the digestion or becoming acid during its continuance, are probably due, more than to any other cause, the discrepancies in this analytical process.

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ESTIMATION OF NITRIC NITROGEN.

By J. BOYD KINNEAR.

So many methods for this purpose have been proposed which have failed in other hands to yield the results obtained by their authors that it is with much hesitation I submit the following process. But it has proved with me so accurate and convenient that I venture at least to offer it to the consideration of others more competent.

The idea of the reduction of nitric and nitrous acid and conversion of the nitrogen into ammonia by the action of zinc and an acid, was long ago suggested, but the results were found to be uncertain and incomplete from the partial production of lower oxides of nitrogen. The advantage, however, which would accrue from operating with a dilute acid and in the cold, instead of with an alkali, or strong acid, and with heat, is so great, especially in presence of organic compounds of nitrogen, that I undertook a series of experiments, with the view of either making the zinc and acid method more complete, or at least of ascertaining some definite ratios of error. Into the details of these it is unnecessary to enter. A comparison of the results showed at last that the method tended to greater accuracy the more the solution of the nitrates operated on was dilute, and that at a certain point of dilution the whole of the nitrogen was combined as ammonia. This point I have not yet precisely determined—possibly it may vary for different combinations. But for practical purposes it may be taken as one of nitrogen (nitric) in five thousand of water, though the reaction will often be found perfect in solutions of twice or three times this strength. The necessary proportions of zinc and acid are indicated by the equation (supposing potassium nitrate and sulphuric acid to be employed)—

$$2KNO_3+8Zn+11H_2SO_4= \\ =8ZnSO_4+2HKSO_4+2NH_4(SO_4)+6H_2O.$$

But it is advisable to use at least a half more of sulphuric acid than is required by the formula, and the larger the surface of zinc the more quickly is the reaction complete. Hydrochloric acid answers as well, and iron might be substituted for zinc but for its liability to contain occluded nitrogen. When only a slight excess of acid is used the action is slow and the evolution of hydrogen trifling, but by employing a moderate excess of acid and nearly filling the vessel with granulated zinc, the evolution of gas is rapid, much heat is produced, and the conversion into ammonia is often complete in ten minutes. In all cases the process must be stopped by pouring off the acid liquid and washing the zinc before the acid is fully saturated.

Besides rapidity and simplicity another advantage is that in many cases the resulting ammonia may be at once estimated in an aliquot portion by the Nessler process. For this purpose care must be taken that the zinc and sulphuric acid are both pure, and that substances which give coloured iodides are absent. Lime and iron, which most frequently occur in ordinary analyses, may be previously precipitated by oxalic acid and potash. When the quantity of zinc dissolved is small the addition of the Nessler solution causes no precipitate, but when it does, the zinc may be first precipitated and re-dissolved by solution of potash. Very rapid and often sufficiently accurate determinations may thus be arrived at, but of course other methods of estimating the ammonia are equally available.

The reaction between the nascent hydrogen and the nitrates and nitrites appears to be quite without effect on organic nitrogen, so much so that the nitric acid in urea nitrate may be thus estimated without the urea being decomposed. The advantage of this in examinations of juices of plants, water, manures, need not be pointed out. When the quantity of the material available is small, it is also an advantage that the same solution may serve for the successive determination, first of the ammonia already formed, next (directly or by difference) of the nitric nitrogen, next of so-called "albumenoid ammonia," and lastly by combustion of the total nitrogen, without risk of results of each process overlapping each other, and thus giving too high a result.

July 5, 1882.

ON THE CAUSE OF THE BLUE COLOUR OF SAPPHIRE, LAZULITE, AND LAPIS LAZULI; THE GREEN OF EMERALD, AND THE PURPLE OF AMETHYST.

By Lieut.-Colonel W. A. ROSS, late R.A.

(1.) In the year 1871, at Mussooree in India, I attempted to obtain a blue colour by dissolving pure alumina to saturation in a borax bead before the blowpipe; and, after a fortnight's work, obtained a very pale blue bead, hard enough to scratch glass. But this experiment took me no further than the presumption that the blue colour of *sapphire* is due only to the 98 per cent of alumina, and not to traces of any supposed metallic oxide which it might contain.

(2.) Matters remained thus until the following year, when, being stationed at Woolwich with my battery, Professor G. G. Stokes did me the honour to witness some of my blowpipe experiments at that place, and eventually to read a paper upon the subject before the Royal Society (*Proc. Roy. Soc.*, vol. xx., p. 449). Among these experiments was one of the treatment of lime before the blowpipe in a bead of pure boric acid, which I found, besides forming transparent sphericles or balls of calcium borate, "caused immediate turbidity over the whole bead;" and this phenomenon was supposed by me at the time to be explainable by the following hypothesis:—"The turbid part would appear to be an attempted solution of the lime by the boric acid; the clear part, a complete solution of the boric acid in the borate of lime." (*Proc. Roy. Soc.*, vol. xx., p. 464).

(3.) But I afterwards found (*a*) that *freshly calcined* lime afforded no turbidity whatever to the boric acid bead, but only a transparent calcium-borate ball within the bead, which, when boiled out of the bead by water, was invariably four times the weight of the calcined lime employed to make it; and (*b*) that *hydrated* lime, on the contrary, rendered the bead completely opaque with turbidity, and then afforded a ball only three times the weight of the hydrate of calcium; the calculation based on this differ-

ence in weight coinciding remarkably closely with that of the amount of water in calcium hydrate, as determined by the calculation of the chemical combining weights.

(4) It thus seemed impossible to doubt that the turbidity caused by the treatment of lime in boric acid before the blowpipe was due to the water contained in the lime, and not to the lime itself; and it was further remarked that, in calcining hydrated lime before the blowpipe, a strong orange-coloured flame was afforded, which ceased when the contained water was thus, in great part, eliminated.

(5.) I now found that the intense orange flame afforded by new platinum-foil rolled up and held in platinum tongs before the blowpipe, caused a precisely similar turbidity or opalescence in a boric acid bead upon which it was allowed to continuously impinge (which opalescent bead can be made to re-hydrate calcined lime), and by fusing (in 1873) some ounces of crystallised boric acid, which previously afforded perfectly transparent beads, in an open platinum dish for several hours over a table blowpipe, I obtained a considerable quantity of opalised or "hydrated" boric acid, which *now* exhales a curious smell of resin on first heating before the blowpipe.

(6.) I also also ascertained that when I dissolved pure alumina before the blowpipe in a bead of this opalised boric acid by means of the addition of a very small proportion of *hydrate* of potash, I obtained a pale blue or bluish bead with much greater rapidity and facility than by the experiment detailed in (1); but still the result was far from satisfactory.

(7.) Some years after this, having begun a series of experiments for the purpose of detecting traces of phosphoric acid in minerals by means of the colour afforded to their solution in boric acid and potash by tungstic acid (confirmed by Mylius in the *Berichte der Deutschen Chemischen Gesellschaft*, for June, 1880, page 1145), I purchased some American *wavellite* in London* for the purpose of experiment, and, upon treating its powder in an opalised or hydrated boric acid bead with a little hydrate of potash before the blowpipe for the purpose of dissolving it previous to the addition of the tungstic acid, I was astonished to find my bead become purple, then blue, and finally a brilliant green colour, without the addition of tungstic acid at all: and I soon found that no other phosphate besides aluminium hydrated phosphate (or *wavellite*) would thus afford coloured beads.

(8.) The next operation was to carefully examine my *wavellite*, which seemed very pure, occurring in the usual pale greenish radiated crystals, without any admixture of matrix. This I effected by treating its fine powder in pure boric acid before the blowpipe; adding potassium carbonate in order to remove the phosphoric acid as potassium phosphate; boiling the bead in distilled water; cautiously adding ammonia until there was no further precipitate; filtering off the residual alumina; and finally testing both residue and filtrate separately in pure boric acid beads before the blowpipe. In this way I could detect nothing but alumina and phosphoric acid.

(9.) Although no phosphoric acid has been detected, either in *sapphire* or *lapis lazuli*, still the equally blue *lazulite* is essentially an aluminium phosphate; and this very American *wavellite* possesses a greenish colour without any apparent cause, unless it be the large proportion of *water* which it contains; whilst pure phosphoric acid is well known to be one of the most deliquescent substances in nature.†

(10.) I now completed my preparations by baking my crushed *wavellite* for several days in an oven, when it became a pale grey colour. I also fused my potassium hydrate on aluminium plate before the blowpipe, because these measures seemed to *concentrate the water* the substances contained, and thus to cause the blue colour to result more certainly and rapidly than with the raw material, with which a very fine green colour is more generally obtained. (Some beads enclosed, marked (*c*); one cut by Hunt and Roskell).*

(11.) To sum up: the materials for the production of these pyrological colours are as follow:—

(*a*.) A bead of opalised or *hydrated* boric acid.

(*b*) Baked pure *wavellite*, or *hydrated* aluminium phosphate.

(*c*.) Fused potassium *hydrate*, to dissolve (*b*) in (*a*) (to be added very cautiously before the blowpipe).

(12.) I showed a pure blue stone thus made and set in a ring, to Dr. Tyndall in 1881, and a small bottleful of green stones to Sir W. Thomson at Swansea in 1880, at the British Association Meeting.

The colours thus producible by the blowpipe alone from these three colourless substances—*hydrated* aluminium phosphate, *hydrated* boric acid, and potassium *hydrate*—are, A, purple or "amethyst"; B, green; C, blue. Heintz proved that the colour of *amethyst* is not due to manganese or titanic acid. The attribution of the green of emerald to a trace of chromic acid by some chemists is founded on a misapprehension, as solutions of chromium before the blowpipe are invariably pink when hot, but solution of emerald is *not*. Finally, it is obvious that when Gmelin found out the way to make artificial lapis-lazuli by synthesis of its constituents, which are colourless, he was no nearer the *cause* of colour than Klaproth was when he found out the constituents of the mineral.

* From Mr. Henson, Mineralogist, of Fleet Street.

† Since then, I have been able to prove, by means of the *assay* balance, the presence and proportion of this "chemical water" in *all* alumina and silica.

* A pure blue bead, made by me from the same materials, has since been sent to the Editor. W. A. R.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 26, June 26, 1882.

Reciprocal Displacements of Acids Combined with Mercuric Oxide.—M. Berthelot.—The author, in studying the salts of mercury, has observed certain facts relative to the displacement of acids,—facts very characteristic, because they show the conditions of coincidence or opposition between the ancient laws of Berthollet and the new thermo-chemical laws. It appears that the acids experimented with arrange themselves, from the thermic point of view, in the following order: Oxalic acid surpasses acetic acid, and is in turn surpassed by hydrochloric acid, whilst hydrocyanic acid prevails over all the others. Hence, according to thermo-chemical principles, oxalic acid ought to decompose mercury acetate; hydrochloric acid should decompose mercury acetate and oxalate, and hydrocyanic acid should in like manner decompose mercury acetate, oxalate, and chloride. Moreover, each of these reactions should be complete, or sensibly so. On the contrary, the laws of Berthollet indicate that acetic and hydrochloric acid combined with mercury oxide, should be equally displaced by oxalic acid on account of the insolubility of mercury oxalate—previsions of which the first is conformable and the second contrary to the former. Berthollet thought, besides, that in the case of two acids forming soluble salts each of them had in the reaction "a share determined by its capacity of saturation and its quantity," that is to say, that two acids employed in equivalent weights take each the half of the antagonistic base, an opinion contrary to the thermo-chemical previsions.

Use of Zinc-Coke Elements in Electrolysis.—D. Tommasi.—The author replies to M. Berthelot's objec-

tions to his last memoir (*Comptes Rendus*, June 5, 1882). He has shown that with two zinc-carbon elements and dilute sulphuric acid, a solution of potassium sulphate is decomposed when the decomposition could not be effected by means of two zinc-platinum elements in dilute sulphuric acid. This experiment has been repeated with solutions of potassium sulphate of different strengths, but no appreciable difference has been observed between the electrolysis of these solutions. The decomposition of potassium sulphate under the circumstances in question cannot be ascribed to the presence of foreign bodies in the coke, for even if it contained metallic substances this would lessen rather than increase the difference of potential at the ends of the circuit. As for the substitution of pure coke for platinum in a zinc-platinum element with dilute sulphuric acid, M. E. Becquerel observed as far back as 1856, that the electromotive force of the element decreased instead of increasing. It has since been found that in elements with two liquids the substitution of coke for platinum either leaves the electromotive force of the element unaffected (Grove's or Bunsen's elements) or greatly increases them (bichromate elements). It does not appear more probable that the increase of the electromotive force of the carbon elements is due to the absorption of hydrogen or oxygen by the coke, since to obtain good results with such elements it is necessary that the coke contains in its pores a gas, *e.g.*, carbonic anhydride, which may hinder or retard the polarisation of the positive electrode.

Silicium.—P. Schützenberger and A. Colson.—The authors have observed the formation of platinum silicide on heating to whiteness a platinum wire in the centre of a thick stratum of lamp-black free from silica. Hence silicium must have been transported from the walls of the crucible through a layer of lamp-black several centimetres in thickness. The addition of titanic acid in fine powder to the lamp-black arrests this transfer. A mixture of lamp-black and iron is ineffectual. Further experiments seemed to show that nitrogen plays a great part in the conveyance of the silicium.

Action of Potassium Bimolybdate upon Certain Oxides.—F. Parmentier.—On setting out with a mixture of corundum and potassium bimolybdate it is possible by lowering the temperature to form a double salt, aluminium potassium bimolybdate along with a more basic molybdate. Water dissolves the mixture, and gives rise to hydrated salts, which a large excess of water destroys, gelatinous alumina being precipitated. Analogous facts have taken place in the formation of certain minerals.

Action of Hydrogen Sulphide on Nickel Sulphate in Acetic Solution.—H. Baubigny.—(See page 17.)

The Alleged Compound NH_2.—M. Combes.—M. Maumené has communicated to the Academy a memoir, in which he studies the action of permanganate upon ammonium oxalate. He asserts that there is produced in this reaction a new body, NH_2 or N_2H_4. The existence of this compound (hydrazine) is theoretically not improbable, since its ethylic and phenylic derivatives are known. The author has repeated the experiments of M. Maumené with the following results: The carbonate which M. Maumené describes, if treated with hydrochloric acid, gives with platinum chloride a precipitate, the appearance and crystalline form of which are absolutely those of ammonium chloro-platinate. The analysis of this precipitate shows that it contains 1·96 to 1·90 per cent of hydrogen, whilst ammonium contains 1·80 per cent, and the body indicated by M. Maumené only 1·35. The aqueous solution of the supposed NH_2, if saturated with hydrochloric acid and concentrated, gives crystals absolutely identical with those of ammonium chloride. Fractionated crystallisations have always given the same result. The analysis of this chloride shows 7·35 to 7·52 of hydrogen. Ammonium chloride gives 7·47, and the chloride of NH_2 only 5·71. In the reaction indicated nothing is produced but ammonia and carbonic acid.

Didymium.—B. Brauner.—Inserted in full as communicated by the author. (See page 16.)

Action of Oxygenated Water upon the Red Colouring-Matter of the Blood, and on Hæmatosine.—A. Béchamp.—Hæmoglobine and hæmatosine behave alike in contact with oxidisable bodies. Oxygen is disengaged correlatively. This is what Thenard ascertained for certain vegetable proximate principles. Thus sugar and starch in contact with concentrated oxygenated water evolve simultaneously carbonic acid and oxygen. It is clear that blood contains two agents capable of decomposing oxygenated water, the microzymas and hæmoglobine.

Gastric Juice.—P. Chapoteaut.—According to the author, pepsine is a compound of an albumenoid with an organic acid, the nature of which he hopes shortly to demonstrate.

Bulletin de la Société Chimique de Paris.
May 5, 1882.

Diazo-benzol Nitrate.—MM. Berthelot and Vieille.—Diazo-benzol nitrate is an explosive crystalline solid. Diazo-benzol is a nitrile, and the nitrate has been proposed as a primer. The authors have studied its formation-heat, its detonation-heat, and its combustion-heat with the density and the pressures developed in closed vessels. Diazo-benzol nitrate is as sensitive to a shock as mercury fulminate. If heated, it detonates with extreme violence at 90°, whilst mercury fulminate does not, under similar circumstances, explode below 195°.

Researches on Nitrogen Sulphide.—MM. Berthelot and Vieille.—This compound, like all the binary compounds of nitrogen except ammonia, is formed with absorption of heat. It is stable in moist or dry air, and may be repeatedly moistened and dried at 50° without appreciable alteration. It detonates under the hammer, but it is less sensitive to a shock than mercury fulminate or diazo-benzol nitrate. If heated, it explodes about 207°, a temperature bordering on the combustion-point of sulphur.

Communications from the Laboratory of the Chemical School of Mulhouse. 1. On Certain Derivatives of Rosaniline.—E. Noelting.—We know that the halogenous aromatic compounds do not possess the property of easily exchanging their halogen or of substituting their aromatic residue in other compounds,—a property which characterises the halogenous compounds of the fatty series. But if we introduce into the aromatic radical one or several groups NO_2, the substance becomes more readily attackable, and the halogen is susceptible of being replaced. Thus ammonia is without action upon mono-chlorated benzol, C_6H_5Cl, but it easily yields dinitraniline with chloro-dinitro-benzol. In the same manner the aromatic chlorides are without action upon rosaniline, but their nitro-derivatives form with this base substitution-products which are colouring-matters, varying in shade from brown to maroon. The author observed this reaction five years ago, and hoped to render it industrial. Unfortunately the colours thus produced are costly, and identical shades may be more cheaply obtained by means of the azo-compounds, rocelline, bordeaux, &c. The chloro-nitro-derivatives which the author has studied are chloro-dinitro-benzol, obtained by the action of nitric and sulphuric acids upon mono-chlorated benzol; picryle chloride and the mixture of chloro-nitro-naphthalines obtained by treating mono-chloro-naphthaline with a mixture of nitric and sulphuric acids. To obtain these colours we heat in a flask on the oil-bath for five to six hours, at from 180° to 200°, a molecule of rosaniline with a molecule of the chloro-nitro-derivative, *e.g.*, chloro-dinitro-benzol with the addition of glacial acetic acid. The mass when cold is broken up and boiled with acidulated water to eliminate unattacked rosaniline. We then filter,

dry, and exhaust with benzol to remove an excess of chloride and a little resinous matter. The residue is the hydrochlorate of the new tinctorial base mixed with a certain quantity of carbonaceous matter. This salt is insoluble in water, but soluble in alcohol. The acetate dissolves also in water. The mass is exhausted with boiling alcohol with the addition of a little acetic acid, and the alcoholic extracts are poured into dilute soda, when the base is precipitated as a paste, which is collected. It is soluble in water acidulated with acetic acid, and may be at once applied in dyeing. Upon silk it produces shades of a violet garnet, approaching a maroon, and very fast as against light and acids. This compound is dinitrophenylic rosaniline. Trinitro-phenylic and dinitronapnthylic rosanilines are prepared in exactly the same manner. Phenylic rosaniline is easily sulpho-conjugated, but this is not the case with its nitro-derivative. Ordinary sulphuric acid chars it without producing a sulphonic acid. By means of chloro-sulphonic acid a sulphoderivative soluble in water is easily obtained. It yields soluble salts, which dye shades very similar to the primitive base. Naphthyl-nitro-rosaniline has a shade much more inclining to violet than the nitro-phenylic derivative.

Dissociation of Trichloro-sulpho-methyl Chloride.—E. Noelting.—At a temperature of 200° this compound is resolved into sulphurous anhydride, carbon tetra-chloride, carbon oxy-chloride, and thionyl-chloride.

Action of Sulphuric Acid upon Proto-catechuic Acid.—E. Noelting and R. Bourcart.—The authors heated for eight hours to 140° to 145° in the 1 grm. proto-catechuic acid, 2 grms. benzoic acid and 50 grms. sulphuric acid at 1·845. The product was a small quantity of a light brown flocculent matter, which dyed mordanted cotton almost like alizarine, but is distinguished by the colour of its alkaline solution and by its absorption-spectrum. The same product was obtained on repeating the experiment without the benzoic acid. The reactions and general behaviour of the compound agree closely with those of rufiopine, obtained in 1856 by Prof. Anderson when acting upon opianic acid with concentrated sulphuric acid.

Archives Neerlandaises des Sciences Exactes et Naturelles, Tome xvii., Livraison 1me.

The Fundamental Formulæ of Electro-dynamics.—H. A. Lorentz.—A mathematical memoir, not capable of useful abridgment.

Tome xvii., Livraison 2me.

This issue contains no chemical matter.

Cosmos Les Mondes.
No. 6, June 10, 1882.

Boric Acid and the Preservation of Alimentary Substances.—Dr. Besana.—Boric acid is used medicinally, and is administered in doses of 20 to 50 centilitres (? centigrammes) at once. But this would be the quantity absorbed by any one who should drink a glass of milk or eat 20 grms. of butter prepared with this substance. This remark should suffice to render both medical men and the public suspicious.

No. 7, 1882.

A Cause of Offensive Odours too often Overlooked.—M. Vanderpol.—The author insists on the well-known fact that sulphates, and especially calcium sulphate, are liable to decomposition in presence of carbonaceous matter, air, and moisture, with liberation of carbonic acid.

Chemical Work produced by the Battery.—D. Tommasi.—Already noticed.

No. 8, 1882.

This number contains no chemical matter not already noticed.

No. 9, 1882.

A New Telephonic Post.—This paper requires the two accompanying illustrations.

Verhandlungen des Vereins zur Beförderung des Gewerbfleisses. April, 1882.

This number contains no chemical novelties.

Revue des Industries et des Sciences Chimiques et Agricoles, No. 57, 1882.

Means of Lowering the Production-cost of Wheat.—H. Joulie.—The author ranks magnesia along with nitrogen, phosphoric acid, lime, and potash. The proportion of nitrogen and of phosphoric acid increases in wheat from the time of blossoming to maturity. Lime, on the contrary, decreases, and does not seem to play a very important part in the production of the grain, but along with potash serves chiefly in the development of the straw. Magnesia is more important than lime in the formation of grain. The mean requirements of wheat in order to produce 40 hectolitres per hectare are—Nitrogen, 92·6 kilos.; phosphoric acid, 37; lime, 25·2; magnesia, 12·2; and potash, 116·2. The "laying" of wheat and other corn is not due to a deficiency of silica in the stalks, but to a diseased condition, consequent on excessive moisture and deficient sunlight.

New Ferric Sulphates.—P. Marguerite-Delacharlonny.—The author enumerates 15 ferric sulphates. Six of them are soluble and contain respectively 2, 3, 4, 5, 6, and 7 molecules of ferric oxide to 12 mols. sulphuric anhydride. The remaining 9 sulphates are insoluble, and contain, along with the same quantity of sulphuric acid, from 9 to 84, or rather $84 + y$ mols. of ferric oxide. The author recognises 11 aluminium sub-sulphates—those with 2, 4, 6, 8, and 10 mols. aluminium sesquioxide to 12 mols. sulphuric anhydride being soluble, and the remaining insoluble with 12, 16, 18, 20, 24, and 30 mols. alumina to 12 mols. of acid. He finds that if alumina is added to a solution of ferric sulphate the ferric sulphate may be entirely displaced, yielding a solution of aluminium sulphate obtained perfectly free from ferric salts.

Purification of the Waste Waters of Manufactories.—Continued from the last number.

MISCELLANEOUS.

Royal Institution.—A new volume of the classified catalogue of the Library of the Royal Institution of Great Britain, by Mr. Vincent, the Librarian, is now ready: it includes the most important works published during the last twenty-five years, placed under their respective heads, accompanied by a Synopsis and Indexes of Authors and Subjects.

Distillation of Coal-Tar.—Professor Lunge has followed up his "Theoretical and Practical Treatise on the Manufacture of Sulphuric Acid and Alkali" by the preparation of a scarcely less important work—although of lesser bulk—on the Distillation of Coal-tar and Ammoniacal Liquor. It will be published, as his previous book was, by Mr. Van Voorst.

A New Isomer of Orcine.—M. E. Knecht has prepared a bioxy-toluene by setting out from metabinitro toluene, which is transferred into nitrotoluidine by partial reduction. This nitrotoluidine successively transformed

into nitrocresylol and amidocresylol gives ultimately an oxycresylol or bioxytoluene.—*Moniteur Scientifique.*

Flameless Combustion.—At the soirée of the Society of Chemical Industry at Owens College, on July 6th, a new theory of combustion was practically illustrated by Mr. Thomas Fletcher, of Warrington, the results being so totally unexpected that many present would, and in fact did, go away with the impression that some deception was being practised. Mr. Jacob Reese, the inventor of the Reese fusing disc, has stated his belief that if it were possible to produce combustion without flame, the temperatures and duty obtained from any fuel would be enormously increased. It has remained for Mr. Fletcher to not only prove the possibility of flameless combustion in more than one form, but also to demonstrate practically the enormously high temperatures which can be obtained by this means. Taking a ball of iron wire about 3 lbs. in weight, Mr. Fletcher placed it on a slab of fire-clay, and directing a blowpipe flame on it for a few seconds, he suddenly blew the flame out. The temperature increased so rapidly that in a few seconds the wrought-iron fused and ran into drops, and this temperature was steadily maintained. The room was darkened, but the closest examination did not show a trace of flame, although the fact that the gas was burning was proved by repeatedly relighting and extinguishing it. The same experiment was repeated in another form by directing the flameless heat into a small fire-clay chamber, in which a refractory clay crucible, made specially for nickel melting, was partially fused and worked into a ball like soft putty, the sides of the fire-clay chamber being at the same time fused. The heat was so tremendous that the blowpipe laboratory which was given up to Mr. Flether for the evening was much too hot to be agreeable, in spite of open windows and ventilators. How far this discovery can be utilised remains to be seen; but it would appear that the presence of flame, usually considered to be a sign of combustion, is really an indication of imperfect results, and the best duty is to be obtained only when flame is totally absent. It is certain that such temperatures as obtained by Mr. Fletcher without flame have never previously been obtained with the fuel used, which was nothing more than a small gas supply for a quarter-inch pipe, assisted by an air blast.—As regards the soirée, the Society may be considered a promising infant. It is under a year old, and about seventeen hundred persons were present, the building being inconveniently crowded. The meeting next year is to be in London, the President for the year being Mr. F. A. Abel, C.B., F.R.S., of the Royal Arsenal, Woolwich.—*Warrington Guardian*, July 12, 1882.

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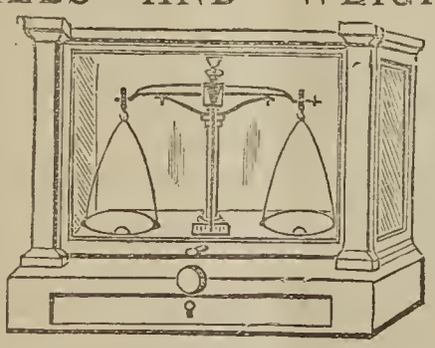

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THE CHEMICAL NEWS.

VOL. XLVI. No. 1183.

APPARATUS FOR THE ABSOLUTE DETERMINATION OF NITROGEN.*

By THOMAS S. GLADDING.

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In the accompanying cut, improvement has been sought on four points.

1st. In a more rapid exhaustion of the combustion-tube.

2nd. In a simpler and easier method of collecting the nitrogen gas.

3rd. In the attainment of a constant suction on the combustion-tube, thereby preventing blowing-out of the tube, so frequently a source of trouble to the analyst; and

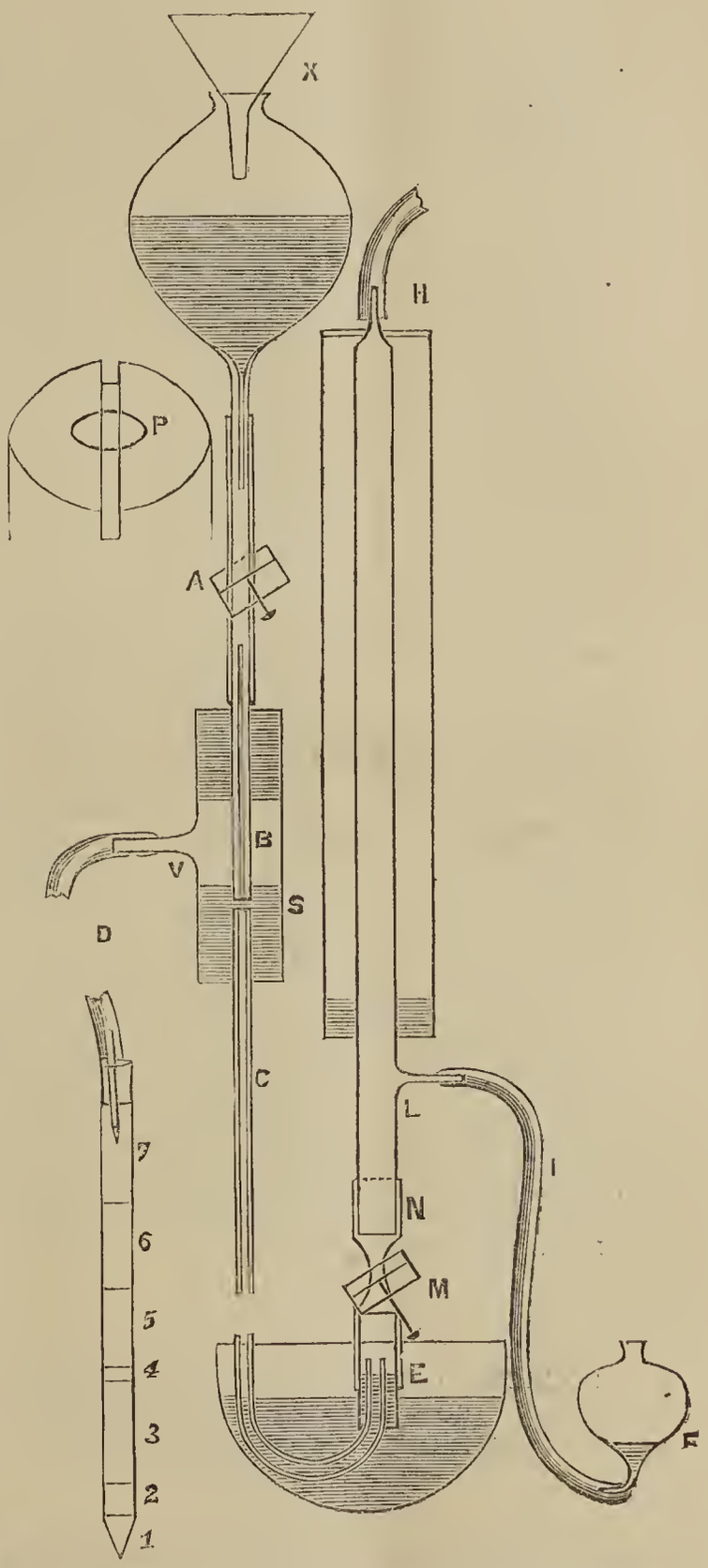
4th. In the more thorough preliminary exhaustion of the combustion-tube and the consequent greater accuracy of the analysis.

A few words only will be needed to explain the accompanying section of the apparatus. Upon the side of the glass tube S is blown a stout piece of glass tubing V. The pure (so-called) rubber tubing D, with walls 4 m.m. thick to prevent collapse from atmospheric pressure, serves to connect the pump with the combustion-tube, and is securely bound to the tubes V and O (which are previously smeared with glycerin) by means of copper wire wound as tightly as possible. This tube D is clamped securely to the wooden frame of the apparatus just beyond the glass tube V, in order to remove the latter from all strain. The barometer tubing C, 7 m.m. in diameter, is forced up to within 5 m.m. of the top of the rubber cork S. The tube B is forced through the cork B into the cork S to within 1 m.m. of the tube C. The bore of B is about one-half that of C and is held exactly over the latter. The flow of mercury is regulated by the clamp A. The rubber tube A is bound tightly to B; its walls are 2 m.m. thick, and it is wrapped with one layer of kid or chamois skin to prevent wear by the action of the clamp A. The tube C is about 45 inches in length and curves up into the glass tube E. A stout glass finger-bowl is admirably adapted to serve as the vessel E. The tube E is connected with N by a large rubber tube tightly bound to both and closed at pleasure by the large screw clamp M. The cork S is shown in nearly top section at P. A slot about 3 m.m. wide and 5 m.m. deep is cut straight across the cork. In this way free access of the gas to be pumped off is given into the tube C, and at the same time the tube B is held exactly over the former.

The first point of improvement, viz., the more rapid exhaustion of the air in the combustion tube, is obtained by the peculiar construction of the pump. The tube B delivers exactly into C, and the bore of C being larger than that of B, there is no choking. The bore of C may be as large as 2 m.m. With such a size a complete vacuum in the combustion tube is easily obtained in from four to five minutes.

The second point of improvement is understood from the figure. The curving of the tube C up into E for the distance of 1½ inches removes all danger of loss of nitrogen and all necessity of handling or moving about any part of the apparatus.

The third point is obtained by the method of collecting the gas. When M is open and the reservoir F is placed a few inches below the level of the mercury in the vessel E, the pressure upon the mercury in the tube E is diminished, the mercury rises slightly in the tube E, and the internal pressure upon the walls of the combustion-tube is correspondingly diminished. Provided no stoppage takes place in the tube itself from too close packing or the use of too fine a filling, no tube can blow out if this device is used. This suction may be increased at pleasure by lowering the vessel F still more, but a gentle aspiration is usually sufficient and safer.



* *The American Chemical Journal*, vol. iv., No. 1.

† *Ibid.*, ii., 27

The fourth point, a more thorough exhaustion of the gas in the combustion-tube, is effected as follows:—About 0·6 grm. of bicarbonate of soda is placed in the tail of the tube at I. The use of chlorate of potash has been found unnecessary in all ordinary work, from duplicate analyses performed with and without it. Its use introduces, moreover, a possible escape of oxygen gas beyond the metallic copper and a consequent error in the analysis. The space 2, about 2 inches in length, is filled with ignited asbestos. This is followed by the substance to be analysed at 3, mixed with copper oxide. This latter is about as fine as sea-sand, and is freed from dust or pulverised copper oxide by means of a fine sieve. It is strongly ignited and mixed with the substance while still warm. At space 4 is another 0·6 grm. of bicarbonate of soda. This is followed by a layer of copper shot at 5, and this again by a layer of coarsely granulated copper oxide. The analysis is begun by drawing the potash solution nearly to the top of the azotometer, then turning up lamps under 6 and at the same time starting the pump. When a perfect vacuum has been obtained and the copper oxide 6 is red hot, the lamp just beyond 1 is turned up, and a gentle heat just sufficient to drive off the CO_2 from it and not to heat space 3 is applied. When the tube is full of CO_2 this lamp is turned off and the tube again exhausted. By this process of washing out the tube, several tenths of a c.c. of additional gas are obtained, and almost the last traces of air are removed. The object in using finely-granulated copper oxide free from the powder is to give full play to this washing. On running the heat back the bicarbonate at 4 gives off CO_2 and re-fills the tube before the combustion of the substance at 3 begins. At this stage draw the potash solution again up to H.

To fill the azotometer with the potash solution, pinch the rubber tube I, and by the suction of the mouth applied at the rubber tube H, draw the mercury up as far as the tube L. Holding it there, close the clamp M, raise the reservoir F and fill it with the potash, which rises of course in the azotometer LH.

While the apparatus is in this condition, the tube remaining filled with mercury from M to L, the azotometer may be lifted and removed from the pump for any repairs without mixing the mercury and potash solution. In this position also it may be washed out for a fresh filling. Lower the reservoir F and invert it into a beaker. Upon opening the cock H all the potash runs out, and the tube HL may be rinsed clean with dilute acid introduced at H. The potash in tube LH may be drawn up to the glass cock H, either by closing the clamp M and then raising F to the level of H, or by the suction of the mouth applied at the rubber tube H. When the apparatus is not in use, F should be on a level with E to prevent any possible aspiration of air into the azotometer tube from the tube C.

Two simple rules may be given to prevent the potash solution in N from ever escaping into the vessel E: Close clamp M (1) whenever F is to be raised above E; (2) whenever the glass cock H is to be opened.

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SOURCES OF ERROR IN DETERMINING IRON IN ORES BY THE STANNOUS CHLORIDE METHOD.

By K. F. FOEHR.

THE volumetric process in question has met with general acceptance, because it yields concordant results in a very short time. Nevertheless, it is not free from considerable sources of error, which, however, chiefly compensate each other. The author shows that in the digestion of ferric ores a not insignificant portion of ferric chloride is volatilised. It may be easily shown that ferric chloride evaporates, even at 50°; if the digestion is performed in a small retort, more or less ferric chloride will be found in the receiver. This is still more the case at the boiling-heat required for titration. This error, however, is compensated by a proportion of pyrolusite, as it is generally found in hydroferrite (bog-iron ore, &c.), and also in the hæmatites. On decomposing such ores with hydrochloric acid there is formed free chlorine, which is partly absorbed by the solution of ferric chloride, and can be entirely expelled only by prolonged boiling, which would lead to an increased loss of ferric chloride.

In dissolving ferrous ores the case is the same, as they have to be first peroxidised by means of potassium chlorate or permanganate. Care must be taken that one of these sources of error does not too greatly exceed the other. The solution should be effected in flasks or beakers, and if the quantity of manganese peroxide present is in large quantity, it may be diminished by roasting.—*Berg. und Hütten Zeitung* and *Chemiker Zeitung*.

ACTION OF SULPHURETTED HYDROGEN UPON NICKEL CHLORIDE.

By M. H. BAUBIGNY.

CERTAIN metallic chlorides are more difficult to convert into sulphides than the corresponding sulphates if submitted under the same conditions to the action of hydrogen sulphide. The author has examined if a similar difference exists in the case of nickel. For this purpose he has taken equivalent weights of the chloride and the sulphate, operating always under comparable conditions, and from these experiments it results that nickel sulphate is converted into sulphide more rapidly than the chloride.

Thus, on making two solutions, each in 140 c.c. of water, 1 of 1·100 grm. of neutral sulphate, and the other of 0·925 grm. of neutral chloride, it was found, on leaving the two solutions for twenty hours at the temperature of the air (12° to 16°) in closed vessels after having saturated them with sulphuretted hydrogen at 0°, that the solution of sulphate contained 0·342 grm. of nickel salt, whilst that of the chloride at the expiration of the same time, contained a weight of nickel corresponding to 0·616 grm. of sulphate. In heat, in an acid liquid, an equally decided difference was found.

If, to the two foregoing solutions of sulphate and chloride, free acid is added, the same in weight as that present in the salt, we find, after having heated to 100° for four hours, only 0·077 sulphate in the solution of that salt, whilst that of the chloride retains a weight of nickel corresponding to 0·215 grm. of sulphate. In the two experiments the gaseous volume of the closed space was the sixth of the liquid volume.

For nickel it is therefore incontestable that the sulphate is more easily decomposed by sulphuretted hydrogen than the chloride, and consequently in comparable conditions hydrochloric acid opposes more energetically than a corresponding weight of sulphuric acid the transformation of nickel into sulphide, independently of any influence of a physical character. Still, as experience shows, the conclusions formed from observations made with nickel sulphate, are equally true for the chloride. With this latter salt, as with the sulphate, the transformation of the metal into sulphide takes place progressively, and is merely much slower. Thus, in a general manner, the action of hydrogen sulphide depends on the relative proportion of acid and metal, on the nature of the acid (sulphuric, hydrochloric, acetic, &c.), on the temperature, on the duration of the experiment, on the relative saturation of the liquid by sulphuretted hydrogen, that is to say, of the tension of this gas, and consequently, in heat, on the relative proportions of the gaseous and liquid volumes in a closed space.

The influencing causes being so many we have an explanation of the contradictory opinions put forward by different experimentators who have studied the separation of nickel from zinc, cadmium, copper, &c., by means of hydrogen sulphide.

For the separation of zinc and nickel in this manner in presence of acetic acid alone, there are required, at common temperatures, quantities of acid so much the greater as the proportion of nickel in solution is greater, and under the influence of a temperature but slightly elevated (40°), even in an open vessel, there is always a precipitation of sulphide. It is sufficient to raise to 70° in an open vessel an acetic solution of nickel acetate, which has been saturated with hydrogen sulphide, letting the liquid cool out of direct contact with the air, so as to avoid a too great loss of sulphurettted hydrogen and the occurrence of oxidation, in order to have all the nickel separated as sulphide, which is entirely deposited in ten to twelve hours.

The method is at fault only if the liquid contains oxidising agents, such as nitrates, but as under these conditions the nitric acid may be destroyed by boiling with ammonium hydrosulphate, it is sufficient to submit the solution to this treatment, repeatedly, if needful, in order to effect a complete precipitation of the nickel as sulphide in presence of free acetic acid.—*Comptes Rendus.*

REVISION OF THE ATOMIC WEIGHT OF ALUMINUM.

By J. W. MALLET, F.R.S.,
Professor of Chemistry in the University of Virginia.

(Concluded from p. 30.)

Calculation of Results.

In calculating the atomic weight of aluminum from the data furnished by the above described experiments, the atomic weights assumed for the other elements involved are those which result from the researches of Stas and the previous investigation by Dumas and Stas of the composition of water, namely—

O = 15·961 S = 31·996 N = 14·010

In regard to silver and bromine a difficulty arises from the fact that the relation between these elements was determined by Stas with metallic silver which, as Dumas* has pointed out, contained in all probability occluded oxygen. It appears from Dumas's experiments and from mine, that the quantity of oxygen that may be so retained varies with the conditions under which the metal is fused, and it is impossible now to ascertain precisely how much was present in that used by Stas, while the correction to be applied on this account, though small, is not inappreciable in its effect upon the atomic weight of the aluminum. Omitting to extract in the Sprengel vacuum the occluded oxygen from the silver used in my experiments would not have secured identical condition of the silver with that of the metal used by Stas, since the circumstances of fusion and cooling would probably not have been altogether the same, and it seemed best to use silver fully purified in this respect, so that my results might be directly comparable with any obtained in the future, since this source of error once pointed out ought not to be hereafter neglected. I have therefore used as the atomic weights of silver and bromine the numbers obtained by Stas (from his experiments on silver bromide and bromate), recalculated on the assumption that the metal employed by him would have yielded 57 c.c. (reduced to 0° C., and 760 m.m.) or 82 m.grm. of oxygen per kilogramme, this being the quantity obtained by Dumas from silver treated as near as possible as was in all likelihood that which Stas employed. This has the advantage of reducing the remaining error to that only which depends on the *difference* between the real amount of oxygen which was present and that assumed in such calculation, instead of leaving the whole resulting from using Stas's numbers uncorrected, my silver having had the oxygen removed, while his had not been so treated. The atomic weights adopted then for these two elements are—

Ag = 107·649 Br = 79·754

Calculated Results.—The following are the values obtained for the atomic weight of aluminum from the different series of experiments, with the probable (mean) value resulting from each set, the difference from this mean of each individual experiment, and the probable error of the mean itself calculated in the usual way by the method of least squares:—

First Series.

A.

Experiment.		Diff. from mean.
I.	Al = 27·029	−0·011
II.	,, 27·043	+0·003
III.	,, 27·055	+0·015
IV.	,, 27·068	+0·028
V.	,, 27·005	−0·035
Mean ..	,, 27·040	
Probable error of mean result ..		±0·0073

B.

VI.	Al = 27·114	+0·018
VII.	,, 27·095	−0·001
VIII.	,, 27·107	+0·011
IX.	,, 27·067	−0·029
X.	,, 27 096	0·000
Mean ..	,, 27·096	
Probable error of mean result ..		±0·0054

Second Series.

A.

I.	Al = 27·035	+0·001
II.	,, 27·021	−0·013
III.	,, 27·046	+0·012
Mean ..	,, 27·034	
Probable error of mean result ..		±0·0049

B.

IV.	Al = 27·028	+0·005
V.	,, 26 993	−0·030
VI.	,, 27·036	+0·013
VII.	,, 27·028	+0·005
VIII.	,, 27·030	+0·007
Mean ..	,, 27·023	
Probable error of mean result ..		±0·0052

C.

IX.	Al = 26·999	−0·019
X.	,, 27·034	+0·016
XI.	,, 27·021	+0·003
Mean ..	,, 27·018	
Probable error of mean result ..		±0·0069

Third Series.

A.

I.	Al = 27·012	+0·007
II.	,, 27·005	0·000
III.	,, 27·022	+0·017
IV.	,, 26·988	−0·017
V.	,, 27·006	+0·001
VI.	,, 26·996	−0·009
Mean ..	,, 27·005	
Probable error of mean result ..		±0·0033

* *Loc, cit.*

B.

Experiment.		Diff. from mean.
VII.	Al = 26·995	+0·005
VIII.	,, 26·999	+0·009
IX.	,, 26·977	−0·013
Mean ..	,, 26·990	
Probable error of mean result ..		±0·0046

In view of the gradual loss of water which, as has been shown, crystallised ammonium alum undergoes on exposure to the atmosphere, I feel that of these various sets of experiments, B of the first series is entitled to least confidence, and the considerable difference between its results and the others leads me to favour its rejection. On the other hand, I am inclined to attach most weight to series three, A, since the method used was very simple in principle, the determination of one of the two quantities concerned was rendered very exact by the great volume of the hydrogen, the comparison was made directly with the standard element in our system of atomic weights and not through the intervention of any other substance whose atomic weight must be assumed, and the agreement of the results among themselves is particularly good, as shown by the probable error of the mean being the smallest reached.

General Mean of Results.—The general mean from all of the thirty experiments, if all be included in the calculation, is Al = 27·032, with a probable error for this mean of ±0·0045.

If series one, B, be excluded, the mean of all the remaining twenty-five experiments is Al = 27·019, with a probable error of ±0·0030. The third decimal having no positive value, we may take Al = 27·02. If integer numbers be used for O, N, C, Na, &c., Al = 27.

All the experiments which I have made are reported, except three or four in which there was manifest failure, as by accidental loss of material to a visible extent, and which were on that account not completed.

The general result adds, I trust, aluminum to the, unfortunately still limited, list of those elementary substances whose atomic weights have been determined within the limits of precision attainable with our present means of experiment.

Bearing of Final Result upon "Prout's Law."

It is interesting to observe that this result also adds one to the cases already on record of the numbers representing carefully determined atomic weights approaching closely to integers, and leads to a word on the reconsideration of "Prout's law." The recent researches of Mr. Lockyer, not unsupported by evidence drawn from other sources, have tended to suggest the possibility, at least, that the forms of matter which as known to us under ordinary conditions we call elements may be susceptible of progressive dissociation at enormously high temperature, and, under circumstances in which this supposed state of dissociation admits of being spectroscopically observed, some of the characteristic features in the spectrum of what is usually known to us as hydrogen become in a very remarkable degree prominent. If such dissociation may really occur, and if the atoms of hydrogen as commonly known to us form either the last term, or any term not far removed in simplicity from the last, in the progressive breaking up of other forms of matter, it is obvious that "Prout's law," or some modification of it, such as was many years ago suggested by Dumas, *must* be true, the atomic weights of all the other so-called elements must be multiples of that of hydrogen, or multiples of that fraction of the hydrogen atom which may result from the dissociation of this body itself. If such fraction be very small as compared with the effect of the inevitable errors of experiment, the experimental verification or refutation of the law will prove impossible, but if it be considerable, as for instance one-half of the commonly known hydrogen atom, or one-fourth, as assumed by Dumas, the question admits of practical examination.

Well deserved attention has for some years past been given to the labours of Stas in this direction; and his main result is no doubt properly accepted, if stated thus, that the differences between the individual determinations of each of sundry atomic weights which have been most carefully examined are distinctly less than their difference, or the difference of their mean, from the integer (or one-half or one-fourth unit which Prout's law would require.

But the inference which Stas himself seems disposed to draw, and which is very commonly taken as the proper conclusion from his results, namely, that Prout's law is disproved, or is not supported by the facts, appears much more open to dispute.

It must be remembered that the most careful work which has been done by Stas and others only proves by the close agreement of the results that *fortuitous* errors have been reduced within narrow limits. It does not prove that all sources of *constant* error have been avoided, and indeed this never can be absolutely proved, as we never can be sure that our knowledge of the substances we are dealing with is complete. Dumas's late observations on the occlusion of oxygen by metallic silver constitute an illustration of this, some of the best of Stas's results being thereby undeniably vitiated, though probably to but a minute extent.

Of course one distinct exception to the assumed law would disprove it, if that exception were itself fully proved, but this is not the case.

As suggested by Marignac and Dumas, any one who will impartially look at the facts can hardly escape the feeling that there must be some reason for the frequent recurrence of atomic weights differing by so little from accordance with the numbers required by the supposed law.

As the question stands at present, the following 18 atomic weights are the only ones which may be fairly considered as determined with the greatest attainable precision, or a very near approach thereto, and without dispute as to the methods employed—

*Oxygen	15·961
*Nitrogen	14·010
Chlorine	35·371†
Bromine	79·757†
Iodine	126·541†
*Sulphur	31·996†
*Potassium	39·042
*Sodium	22·987
*Lithium	7·005
Silver	107·667†
Thallium	203·655‡
*Aluminum	27·019
*Carbon	11·97
*Phosphorus	30·06
Barium	136·84
Calcium	39·90
*Magnesium	23·94
Lead	206·40

† Stas's numbers, uncorrected for occlusion of oxygen by silver.
‡ Crookes's number modified by taking O = 15·961 instead of 15·96.

If now we discard altogether Dumas's assumption of multiples of 0·5 or 0·25, and consider simply the indications afforded of Prout's law in its original form, we may safely take the first decimal place of each of these numbers as quite freed from the influence of *fortuitous* errors, while the second decimal is nearly so in many instances. It appears that out of the 18 numbers, 10 (those to which an asterisk is prefixed) approximate to integers within a range of variation less than one-tenth of a unit. What then is the degree of probability that this is purely accidental, as those hold who carry to the extreme the conclusions of Berzelius and Stas? Since there are five intervals of 0·1 each between any integer and the 0·5 which

divides it from the next higher (or lower) integer, the result is given by the expression—

$$5^{-18}\left[1+\frac{\lfloor 18}{\lfloor 17}\times 4+\frac{\lfloor 18}{\lfloor 16\,\lfloor 2}\times 4^2+\frac{\lfloor 18}{\lfloor 15\,\lfloor 3}\times 4^3+\ldots\frac{\lfloor 18}{\lfloor 10\,\lfloor 8}\times 4^8\right]$$

and the probability in question is found to be only equal to 1 : 1097·8.

Of course this result might be easily varied by assuming other limits of precision as marking accordance with the law within the range of possible constant error, but this example seems to be based upon not unfairly assumed ground in this respect, and seems sufficiently to illustrate the point that not only is Prout's law not as yet absolutely overturned, but that a heavy and apparently increasing weight of probability in its favour, or in favour of some modification of it, exists and demands consideration.

THE DETECTION OF CHLORIDE OF LIME IN WATER.

By A. ANTHONY NESBIT, F.C.S.

THE increasing disputes between owners of paper mills and those preserving fish have rendered it advisable that chemists should have a very delicate test for bleaching-powder, which is the most deleterious pollution of streams by paper mills. I have consequently conducted a long series of experiments which have resulted in the following method, the delicacy of which is such that it enables us to detect from the 200th to the 400th part of that quantity of chloride of lime which is injurious to prussian carp (*Cyprinus Gibelio*).

The test used is a starch paste made in the following manner. 100 grs. of iodide of potassium are dissolved in 16 ozs. of boiling water and 100 grs. of starch mixed with 1 oz. of cold water are added gradually, and the whole boiled vigorously for 30 minutes (the long boiling being absolutely necessary for the production of the sensitiveness of the test).

This solution should be used as soon as possible after its preparation, as it rapidly decreases in delicacy, and the extraordinary fact must never be lost sight of that an excess of this test entirely destroys the reaction.

I test a water in the following manner, viz., two No. 5 beakers of the same shape are filled with the water under examination from the brook side and placed on a sheet of white paper, and 5 c.c. of the above solution are run from the burette into one of them; if no blue or violet colour occurs at once, the water is thrown away, the beaker is re-filled and 1 c.c. run in; if again no reaction, the beaker is again re-filled and half a c.c. added, the beaker re-emptied, and so on, till only the tenth of a c.c. is used in the beaker—it being found that the smaller the quantity of chloride of lime present the smaller the quantity of test required to exhibit it, and when we are dealing with small quantities of the chloride it has to be searched for with varying amounts of the test or it may escape notice.

By judiciously applying the above method I can detect the $\frac{1}{200}$th of a grain of commercial bleaching-powder in one gallon of water, or about $\frac{1}{800}$th of a grain of "available chlorine" in a gallon.

Now from numerous experiments which I have conducted I find that it requires from one to two grains of commercial chloride of lime to inconvenience prussian carp, consequently we can readily detect in so-called polluted water the $\frac{1}{200}$th to the $\frac{1}{400}$th part of the quantity which is injurious to these fish; and hardy as the prussian carp are, I think it must be conceded that it would be unreasonable to consider that the common trout is two hundred times as delicate.

In future disputes, therefore, between the owners of paper mills and fish preservers there will be no difficulty in deciding whether or no the manufacturer habitually discharges an injurious quantity of chloride of lime into the stream.

I find, however, that chloride of lime in small quantities is rapidly reduced by the action of the organic matter in the water, which fact must not be lost sight of, and every hour's delay in testing makes it more difficult to indicate pollution.

REMARKS ON DIDYMIUM.

By M. P. T. CLÈVE.

THE author has recently communicated to the Academy a preliminary note, the purpose of which was to render probable the existence of an unknown element between lanthanum and didymium, and accompanying the latter in a certain number of minerals. As a characteristic of this hypothetical element, provisionally designated Diβ, the author gave the spectral ray $l=4333{\cdot}5$, which is not found among the rays of lanthanum and didymium as laid down in 1874 by M. Thalèn. Continued researches have subsequently convinced himself and M. Thalèn that this ray belongs in fact to the spectrum of lanthanum, and that it is omitted in M. Thalèn's tables by an error. The latter, in place of this ray, has indicated another adjacent and very strong ray, $l=4330$, which does not exist in the spectrum of lanthanum. There is here evidently a clerical error which has misled the author. An examination of the fractions intermediate between lanthanum and didymium has rendered the existence of an intermediate element scarcely probable. It seems to result from the researches of M. Brauner (see CHEMICAL NEWS, vol. lxvi., p. 16) that there is a variation in the atomic weight of didymium, which must be ascribed—as M. Brauner in fact does—to the presence of a foreign oxide. If this oxide is new, decipium has yet to be discovered. At present it appears very improbable that it is precipitated by ammonia after the true didymium.—*Comptes Rendus.*

Appearances of the Electric Arc in the Vapour of Carbon Disulphide.—MM. Jamin and Maneuvrier.—The authors have already described the modifications which the electric arc undergoes in the vacuum of pneumatic machines, when it is produced by a Gramme machine with alternating currents at high tension. The appearances are modified if gases or vapours are introduced into the vacuum, and are especially remarkable in the vapour of carbon disulphide. When the carbon points are separated there is a sort of explosion of light, incomparably superior to the ordinary lustre of the arc. On viewing it through darkened glasses we see a dazzling arc of the shape of a horse-shoe, with its extremities at the carbon points, and, besides, a long flame which escapes from the arc and rises vertically. The points of the carbons are red and very bright, but the arc is of a pale green, which predominates. The lustre increases so as to become intolerable as the tension of the vapour increases, but as the resistance of the medium augments at the same time, the arc is often extinguished, and it must be re-lighted by joining the two carbons. The spectrum is composed of four channelled parts in the red, the yellow, the green, and the violet, so identical that they might be taken for one and the same design transferred from the red to the violet. It is not probable that the light thus obtained will be of any practical value on account of its colour, except for lighthouses and signals sent to a distance.—*Comptes Rendus*, xcv., No. 1.

RESEARCHES ON THE SUBSTITUTED BENZYL COMPOUNDS.

THE SYNTHESIS OF ANTHRACENE AND PHENANTHRENE FROM ORTHO-BROM-BENZYL-BROMIDE.*

By C. LORING JACKSON and J. FLEMING WHITE.

Discovery of Anthracene.

THE first notice of anthracene (under the name para-naphthaline) appears in a paper† on compounds of hydrogen and carbon, published by Dumas and Laurent in 1832. They obtained it in the fractional distillation of coal-tar from the portions with the highest boiling-point, but did not succeed in purifying it, as is shown by the melting-point 180°, and the formula $C_{15}H_6$. Laurent,‡ in 1835, studied its oxidation-product "para-naphthalese" (anthraquinone), and in 1837§ proposed the name anthracene for it; but neither of these papers, nor one‖ also published by Laurent in 1839, gives a satisfactory account of the hydrocarbon, as the quantity at his disposal was too small for complete purification.

The first accurate characterisation of anthracene is due to Fritzsche,¶ who, in 1857, obtained from coal-tar a hydrocarbon with the formula $C_{14}H_{10}$, and melting-point 210°, forming a picric acid compound melting at 170°, but he did not identify it with the anthracene of Laurent. This was reserved for Anderson,** who, in 1861, repeated Laurent's experiments on a larger scale, and showed that his anthracene had the formula $C_{14}H_{10}$, melted at 213°, and was the same as Frizsche's unnamed hydrocarbon.

In 1867, Fritzshe†† described the preparation of his reagent (dinitro-anthraquinone), and its use in the detection and purification of hydrocarbons; and Berthelot‡‡ reviewed all the previous work upon anthracene, determining its boiling-point 360° for the first time.

The next important paper on the subject appeared in 1869, when Fritzsche,§§ on account of its behaviour with his reagent, pronounced anthracene a mixture of two very similar hydrocarbons, which he called photene, melting-point 210° to 212°, and phosene, melting-point 193°.

In the following year (1870) general attention was attracted to anthracene by the appearance of Graebe and Liebermann's famous paper‖‖ on anthracene and alizarine, in which they not only proved that alizarine was dioxy-anthraquinone by preparing it synthetically from anthracene, but described a large number of derivatives of anthracene, giving for the first time the melting-point of anthraquinone 273°. They showed, too, that Fritzsche's photene was identical with anthracene, but were unable to obtain his phosene, which Barbier¶¶ four years later showed was probably a mixture of anthracene and phenanthrene.

Syntheses of Anthracene.

In describing the syntheses of anthracene, all those made by the same method will be grouped together, and these groups will be taken up in the order of their discovery.

1. Limpricht*** was the first (in 1866) who made anthracene synthetically, unless, indeed one of the products obtained by Märcker,††† in 1865, from the action of heat on tolallyl-sulphide must be considered anthracene-sulphide, but there seems to be no sufficient ground for this supposition. Limpricht's method consisted in heating benzyl-chloride with water in a sealed tube to 190° for eight hours; the products were benzyl-ether, an oil $C_{14}H_{14}$, and anthracene.

Van Dorp,* in 1872, obtained the same result, and proved that the oil $C_{14}H_{14}$, which Limpricht had thought was dibenzyl, is benzyl-toluol. Finally Zincke,† in 1874, showed that this reaction resembled that of zinc-dust on a mixture of benzyl-chloride and benzol, and succeeded in isolating a chloride, $C_6H_5CH_2C_6H_4CH_2Cl$, and a complex hydrocarbon. He proved, further, that this synthesis was of little value in determining the constitution of anthracene, since neither anthracene nor benzyl-toluol was present in the product of the reaction, but they were formed during distillation by the breaking up of the more complex substances just mentioned.

2. In the year after Limpricht's synthesis was published, Berthelot, in developing his general method for the synthesis of complex hydrocarbons by passing simpler ones through a porcelain tube, heated to redness, obtained anthracene‡ from toluol (confirmed by Graebe§ in 1874), xylol, cumol, and mixtures of benzol with ethylene,‖ and of benzol with styrol; also traces of it by heating acetylene to redness in a glass tube over mercury. The same method was applied successfully by Van Dorp¶ to benzyl-toluol, that obtained from benzyl-chloride toluol and zinc-dust, as well as that from benzyl-chloride and water; by Kramers** to phenol (yellow heat); by Claus and Suckert†† to azobenzol; and by Barbier‡‡ to the mixture of toluol with benzol, and to that of diphenyl with ethylene, although the latter yielded only traces of anthracene. Barbier, in 1874, substituted for red-hot porcelain tubes vacuous sealed glass tubes heated to dull redness for a few minutes, and obtained in this way anthracene from benzyl-toluol, phenyl-xylol, diphenyl-methane, and liquid ditolyl. While Behr and Van Dorp§§ obtained the same result a year earlier by passing liquid benzyl-toluol, or liquid tolyl-phenyl-ketone, over gently-heated plumbic oxide. The synthesis from ortho-tolyl-phenyl-ketone by the aid of heat has been recently repeated by Ador and Rilliet.‖‖

3. The next synthesis of anthracene was published in 1872 by Kekulé and Franchimont,¶¶ who obtained a small quantity of anthraquinone from the by-products of the distillation of calcic benzoate. Their results were confirmed by Behr*** and Staedel.†††

4. Related to this method is that of Barth and Senhofer,‡‡‡ published in 1873, which consists in heating oxybenzoic acid alone, or with sulphuric acid.

5. In 1873, also, anthracene was first obtained by Zincke's reaction; for, although Zincke§§§ had not succeeded in finding it, Radziszewski and Zaleski‖‖‖ got it from zinc-dust, benzyl-chloride and benzol, and Paterno and Filetti¶¶¶ by the action of zinc-dust on a mixture of benzyl-chloride and phenol; the latter, however, think that it is not formed directly, but by a secondary reaction from the benzyl-phenol, and this view is supported by a paper published in the following year by Zincke and Weber,**** who obtained it from a mixture of zinc-dust,

* Presented to the American Academy. Communicated by the Authors.
† *Ann. Chim. Phys*, 50, 187.
‡ *Ibid.*, 60, 220.
§ *Ibid.*, 66, 149.
‖ *Ibid.*, 72, 415.
¶ *St. Petersburg Acad. Ber.*, 1857; *Journ. Prakt. Chemie*, 73, 286.
** *Ann. Chem. Pharm.*, 122, 294.
†† *Zeit. für Chemie*, 1867, 289
‡‡ *Bull. Chim. Soc.*, 8, 231.
§§ *Zeit. für Chemie*, 1869, 387.
‖‖ *Ann. Chem. Pharm.*, Supp., 7, 257. A preliminary notice appeared in 1868, *Ber. Deutsche Chem. Gesell.*, 49.
¶¶ *Comptes Rendus*, 79, 121.
*** *Ann. Chem. Pharm.*, 139, 308.
††† *Ibid.*, 136, 94.

* *Ber. Deut. Chem. Ges.*, 1872, 1070; *Ann. Chem. Pharm.*, 169, 207.
† *Ber. Deut. Chem. Ges.*, 1874, 276.
‡ *Bull. Chem. Soc.*, 7, 222.
§ *Ber. Deut. Chem. Ges.*, 1874, 48.
‖ *Bull. Chem. Soc.*, 7, 279.
¶ *Ber. Deut. Chem. Ges.*, 1872, 1070; *Ann. Chem. Pharm.*, 169, 207.
** *Ann. Chem. Pharm.*, 189. 131.
†† *Ber. Deut. Chem. Ges*, 1875, 37.
‡‡ *Comptes Rendus*, 79, 121, 600, 810; also *Ann. Chim. Phys.*, series 5, 7, 515.
§§ *Ber. Deut. Chem. Ges.*, 1873, 753.
‖‖ *Ibid.*, 1879, 2208.
¶¶ *Ibid.*, 1872, 909.
*** *Ibid.*, 1872, 971.
††† *Ibid.*, 1873, 178.
‡‡‡ *Ann. Chem., Pharm.*, 170, 100.
§§§ *Ber. Deut. Chem. Ges.*, 1873, 137.
‖‖‖ *Ibid.*, 1873, 810.
¶¶¶ *Gazz. Chim.*, 1873, 121.
**** *Ber. Deut. Chem. Ges.*, 1874, 1153.

benzyl-chloride and toluol, but suppose that all the anthracene is formed by the breaking up of complex hydrocarbons during the subsequent distillation, in the same way that it is formed from the product of the action of water on benzyl-chloride. More interesting, therefore, is the synthesis of Piccard,* who obtained anthraquinone by the action of zinc-dust on the chloride of phthalic acid and benzol at 220°.

Under this head should come also the recent experiments of Friedel and Crafts,† who, among their beautiful syntheses with aluminic chloride, made anthraquinone from the same mixture, and finally of Ador and Rilliet,‡ who, in 1879, obtained it from the chloride of ortho-toluic acid, benzol, and aluminic chloride.

6. Paterno and Filetti,§ in a paper published somewhat later, in 1873, describe the synthesis of anthracene by the distillation of benzyl-phenol with phosphoric pentoxide.

7. In the same year appeared a paper by Grimm,‖ from Baeyer's laboratory, describing the synthesis of chinizarine from phthalic anhydride, hydroquinone, and sulphuric acid; while in 1874, Baeyer and Caro¶ found that phthalic anhydride yielded, with phenol, benzol-sulpho-acid, anisol, anisic acid, or salicylic acid, either oxy-anthraquinone or erythroxy-anthraquinone, both of which give alizarine by fusion with potassic hydrate; with pyro-catechin, guaiacol, or proto-catechuic acid, alizarine; with hydroquinone (see Grimm), quinic acid, thio-chronic acid, or the α- and β-sulpho-acids of hydroquinone, chinizarine. Still later, in 1875,** they added chlorphenol, boiling-point 218°, to the list of substances which form chinizarine, and converted chinizarine into purpurine by oxidation.

In his last paper†† on phthaleines and their derivatives, published in 1880, Baeyer shows their close relation to the anthracene group, ordinary phthalidine being dioxy-phenyl-anthranol, while a corresponding compound can be obtained from triphenyl-methane carbonic acid.

8. The syntheses of anthraquinone from benzoyl-benzoic acid also begin in 1873, when Plascuda and Zincke‡‡ obtained a little in oxidising crude benzoyl-toluol. In the following year Behr and Van Dorp§§ made it by oxidising tolyl-phenyl-ketone, and somewhat later in the same year converted β-benzoyl-benzoic acid into anthraquinone‖‖ by heating it with phosphoric pentoxide, a process which ran smoothly and yielded 26 per cent of the theoretical amount, whereas the para-acid, under the same conditions, gave no anthraquinone whatever. The formation of traces of anthraquinone from the distillation of calcic benzoate alone, and of benzoic acid with phosphoric pentoxide, they ascribed to the previous formation of β-benzoyl-benzoic acid. Liebermann¶¶ next showed that fuming sulphuric acid produced essentially the same effect as phosphoric pentoxide, converting the β-benzoyl-benzoic acid into anthraquinone sulpho-acid, and suggested that this method might be of technical value in the future. Rotering and Zincke*** obtained a similar result by using phosphoric penta-chloride, while Thörner and Zincke††† worked out the process further, and showed that chlorine acting on ortho-tolyl-phenyl-ketone produced the same effect. Under this head might also be classed the action of hot plumbic oxide on tolyl-phenyl-ketone already described in Group 2.

9. Closely related to the preceding group is the synthesis depending on the action of zinc-dust on tolyl-phenyl-ketone, which was studied by Behr and Van Dorp in 1873;* and also in 1874,† when they proved that the para-compound gives no anthracene, and more recently by Ador and Rilliet.‡

Finally, the occurrence of (10) anthracene among the products of the action of potassic nitrite on benzyl-chloride,§ and of (11) anthraquinone from the oxidation of isatropic acid,‖ should be mentioned.

(To be continued.)

* *Ber. Deut. Chem. Ges.*, 1874, 1785.
† *Comptes Rendus*, 84, 1450.
‡ *Ber. Deut. Chem. Ges.*, 1879, 2298.
§ *Gazz. Chim.*, 1873, 251.
‖ *Ber Deut. Chem. Ges.*, 1873, 506.
¶ *Ibid.*, 1874, 968.
** *Ibid.*, 1875, 152.
†† *Ann. Chem. Pharm.*, 202, 36.
‡‡ *Ber. Deut. Chem.*, 1873, 506.
§§ *Ibid.*, 1874, 16.
‖‖ *Ibid.*, 1874, 578.
¶¶ *Ibid.*, 805.
*** *Ibid.*, 1876, 631.
††† *Ibid.*, 1877, 1477.

* *Ber. Deut. Chem. Ges.*, 1873, 753.
† *Ibid.*, 1874, 16.
‡ *Ibid.*, 1879, 2298.
§ Brunner, *Ibid.*, 1876, 1744.
‖ Fittig, *Ibid.*, 1879, 1739.
¶ "Manual of Sugar Analysis."

CORRESPONDENCE.

SUGAR ANALYSIS.

To the Editor of the Chemical News.

SIR,—Referring to the letter printed under this heading (CHEM. NEWS, vol. xlvi., p. 22), I think your correspondent is certainly in error in stating that such sugar chemists as Tucker would fail to detect the presence of starch sugar when mixed with the product of the beet or cane. On p. 136¶ Tucker expressly states that the percentage of cane sugar may be read directly on the saccharimeter "when no other optically active body is present." This, I take it, covers the whole ground of contention in reference to starch sugar, which is, as everybody knows, optically active, and samples containing it require therefore to be further tested by processes given in detail in Tucker's book. Such being the case it is hardly fair to pick out an isolated sentence, and on this solitary statement proceed to draw the inference that "such sugar chemists as Tucker" would pass over the presence of starch sugar in a mixture of that substance with cane sugar. Now, as a matter of fact, some solid starch sugars will, when mixed with refiners' pieces, so increase the specific rotation of the sample as to give readings above 100 per cent—this being due to the high specific rotatory power of dextrine $[\alpha]_D$ + 193, and maltose $[\alpha]_{D'}$ + 139·2 as against $[\alpha]_D$ 66·5, that of cane sugar.

Your correspondent I consider takes an unfair advantage when he quotes in one paragraph of his letter Professor Wiley's analyses as proving the serious error introduced by heating starch sugar with hydrochloric acid. These experiments were made on liquid glucose and solid grape sugar prepared for confectioners' use, both these substances containing considerable quantities of dextrine and maltose, which very naturally undergo further conversion into dextrose in the presence of large excess of acid, when heated, with consequent reduction of rotatory power; in calling attention in an ensuing paragraph to what he calls "another error" in Tucker's book he states that mixed cane and starch sugars do not polarise higher but lower than pure cane sugar on account of the lower specific rotatory power of "highly converted starch sugar" or dextrose. Now surely this is hardly fair.

If cane sugars are mixed with liquid glucose or confectioners' grape sugar, such as was experimented on by Professor Wiley, the direct polarisation would undoubtedly in many cases cause the analysis to add up to more than 100, but, says your correspondent, only *highly converted* starch sugar is used, which is really almost pure dextrose, and therefore the direct polarisation is lower than the true one, so that in one paragraph your correspondent states on authority that commercial starch sugars (liquid glucose and confectioners' grape sugar) do alter by heating with hydrochloric acid, in the ordinary inversion process, and in the next paragraph he asserts that the polarisation of a mixed sugar is lower than the correct reading (which is impossible were such sugars used for mixing

as those experimented on by Wiley), on account of the starch sugar being in such a highly converted state that it consists of dextrose, the rotation of which substance would not be altered by the inversion process of Clerget.

As a rule the manufacturer of this mixed sugar is sufficiently educated by the American chemist to select for his purpose almost pure dextrose, which can be manufactured in the state of a white powder, and this he mixes with crushed loaf or other powdered white sugar. The detection of this sophistication is perfectly easy to those who are acquainted with the appearance and properties of commercial sugars. In the case of the class of sugars known as "Dutch crushed," the mere fact of the direct reading on the saccharimeter falling as low as the highest figure, 93·7, quoted by your correspondent, is sufficient to indicate that the sample is of American origin, and therefore suspicious, while a figure so low as 78·5 is only approached by the lowest Manilas and Jaggerys sugars, so impure as to be utterly unfitted for direct consumption. So that sugars (which from their general appearance and whiteness would be classed as commercially pure articles) giving such low polariscopic readings would at once cause them to be made the subject of special enquiry and exhaustive analysis.

Had your correspondent carefully read Tucker's book it would have assisted in dispelling some of the mist which is evidently enveloping his brain, and he would have a clearer idea of the various differences between starch sugars: more especially he would have understood that liquid glucose and confectioners' grape sugar are not "highly converted" articles, and that the "highly converted" article consists of pure dextrose, which is worth little more than half the price of cane sugar, and which science in America has assisted her manufacturers and refiners in so successfully introducing into cane sugar under such extremely favourable monetary conditions.—I am, &c.,

R. H. HARLAND.

37, Lombard St., London,
July 18th, 1882.

DETERMINATION OF ARSENIC IN COPPER.

To the Editor of the Chemical News.

SIR,—My attention has been called to an article in the issue of your journal (CHEM. NEWS, vol. xlv., p. 255), which had hitherto escaped my notice. It is on the determination of arsenic in copper, and in it the author, Mr. A. Humboldt Sexton, claims in respect of one method which I may call the iron method that he devised it. That particular process was communicated to me by the late Mr. W. J. Ward, with whom I sometimes exchanged notes on metallurgical analysis, and whose experience in these matters was very extensive. I introduced the process into my laboratory, and there Mr. Sexton got his knowledge of it in his capacity of my laboratory assistant. In the same capacity he made at my direction certain experiments on the *modus operandi* to which he appears to refer in his paper.

I don't think it is necessary to say more on this subject, and leaving the matter to the judgment of yourself and your readers,—I am, &c.,

DAVID WATSON.

The Broughton Copper Company, Limited,
Manchester, July 24, 1882.

SALT IN BEER.

To the Editor of the Chemical News.

SIR,—In a recent case a certificate of one of the public analysts was upset by the superior certificate of the Somerset House authorities, who had taken into consideration the amount of sodium salts being low. As this is (to my knowledge) the first instance of the soda salts being examined, will you allow me to point out how such reasoning, albeit that it was more correct, can in some instances be rendered untrustworthy. I do not intend to criticise the facts of the case alluded to, as the commissioners' decision seems to have been perfectly reasonable and just.

1. Many waters, notably those of the chalk beneath the London clay, contain sodium as carbonate and sulphate, much exceeding that as chlorides. Here a guilty party can escape by reason of the doubtfulness.

2. The ratio between potash and soda cannot be introduced, since low class sugars, maize, &c., are so variable in use.

3. The disturbing effects of the addition to beer of chloride of magnesium, which would be liable to be found on analysis as chloride of potassium.

4. The disturbing effects of a preservative agent composed of chloride of potassium and sodium, according to Patent 1880—1471.

5. The variation of the ash of malt consequent on longer or shorter "steeping" of the barley in water.

6. The absence of a series of standard analyses of the alkalies in beer ash.

On these grounds I believe that if we desert the old system of examination of materials for chlorine with allowance thereof, and substitute instead allowance for soda *without further enquiry*, we are entering upon a course which, though in many cases useful, is certain to defeat its own object by casting unnecessary doubts on every analysis.—I am, &c.,

OBSERVANS.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 1, July 3, 1882.

Electrolysis of Oxygenated Water.—M. Berthelot.—The author explains on thermo-chemical principles the two distinct modes of the electrolytic decomposition of oxygenated water, with and without the disengagement of hydrogen. These two modes may co-exist, as the author has shown in his study of the electrolysis of iron and manganese sulphates. The co-existence is shown by the variation of the volume-proportions of hydrogen and oxygen liberated.

Electromotor Force of a Zinc-carbon Element.—M. Berthelot.—In this paper, which is a critique on those of M. Tommasi on the same subject, the author maintains that the zinc-carbon battery, from the fluctuating nature of its effects, is unfit for any operation which requires a constant electromotor force. The chemical effects vary in a correlative manner. If two zinc-carbon elements decompose potassium sulphate whilst two zinc-platinum elements do not, it is because the chemical reactions in the two cases are not the same.

Decomposition of Gallium Protochloride by Water.—M. Lecoq de Boisbaudran.—In a former communication the author has described the disengagement of gases which accompanies the solution of anhydrous gallium protochloride in water, pure or acidulated (*Comptes Rendus*, August, 1881, p. 295). This disengagement, scanty when the liquid remains concentrated, becomes tumultuous if it is largely diluted. A result quite analogous is produced when metallic gallium is dissolved in the cold in a small quantity of concentrated hydrochloric acid. There escapes a regular current during the whole continuance of the action, and there remains a clear liquid, which if left to itself gives off gas very slowly, but which liberates torrents as soon as it is diluted with

water. Each new dilution occasions a fresh escape of gas, the intensity of which decreases progressively until a limit is reached at about 10 c.c. for 0·1 grm. of the gallium employed. If the metal were less rare this reaction might be the subject of a curious lecture experiment.

Theory of the Equipotential Figures obtained by the Electro-chemical Method.—Ad. Guébhard.—The rings of Nobili owe their origin not to a permanent electric condition, but to a very brief variable state, and to a kind of reaction of the slender layer of metal, which after having at first afforded the most easy track for the current, tends almost immediately after to repel it.

Determination of Vapour-Densities in Glass Globes at the Temperature of the Boiling-point of Selenium.—M. L. Troost.—The author having first described his experimental arrangements, shows that the vapour of iodine has at or about 665° a coefficient of expansion differing very slightly from that of the air, whilst its coefficient of compressibility is even at 440° strikingly different from that of the air. The vapour of sulphur, on the contrary, has a density at 440°, independent of pressure. It preserves at this temperature, however feeble the pressure, the value 6·6, threefold of the value 2·2, which it has at elevated temperatures. It behaves like ozonised oxygen, the density of which, equal to one and a half times that of ordinary oxygen, is at 10° independent of pressure. As ozone is gradually decomposed as the temperature rises, returning to the state of ordinary oxygen, it was interesting to determine that the vapour of sulphur passes, like oxygen, progressively from one allotropic state to another as the temperature rises, and that consequently its vapour-density taken at an intermediate temperature between the boiling-point of sulphur and that of cadmium, has a value intermediate between 6·6 and 2·2.

Remarks on Didymium.—M. P. T. Clève.—(See page 43.)

Action of Sulphuretted Hydrogen after Nickel Chloride.—M. H. Baubigny.—(See page 41.)

The Isomerism of Cuprous Sulphites.—M. Etard.—There are two isomeric cuprous sulphites, the one white, of sp. gr. 3·83 at 15°; the other red, of sp. gr. 4·46 at the same temperature. The former, which the author has identified for the first time, is the normal salt, corresponding to the colourless cuprous chloride and acetate. The second is a polymer, and the author names it cuprous iso-sulphite.

Reduction of certain Ores of Silver in the Moist Way by Hydrogen.—M. P. Laur.—Whenever hydrogen takes its rise in a liquid containing silver sulphide, chloride, bromide, and iodide, the silver compound is destroyed, and the silver is deposited in the metallic state. The following reaction may be utilised in metallurgy:—The silver ore is ground to a fine powder, and put in a cast-iron vessel, into which is poured a weak alkaline lye, 1 part soda to 100 parts water. There is also prepared an amalgam of 3 parts tin to 100 parts mercury, which is added to the ore, and the whole is raised to a boil. The hydrogen decomposes the argentiferous compounds. The silver amalgamates with the mercury, the sulphur passes into the liquid as an alkaline sulpho-stannate, whilst the chlorine, iodine, and bromine give corresponding sodium salts. There is no appreciable loss of mercury. This reaction might be usefully substituted for the Mexican "Cazo" and the Californian "Pan" processes. The waste of mercury is suppressed, and the extraction of the silver is more complete.

Action of Chloroform upon β-Naphthol.—M. G. Rousseau.—This reaction gives rise to various products, which may be classed in two very distinct groups:—1st. Bodies insoluble in alkalies, namely, glycol, glycolic ether, a monatomic alcohol, and a resin containing 96 per cent of carbon. 2nd. Bodies soluble in alkalies, *i.e.*, aldehyd and a highly oxygenised resin.

The Introduction into the Arts of Vanadium Extracted from the Basic Slags of Creusot.—MM. G. Witz and Osmond.—M. Dieulafait has recently shown the general diffusion of vanadium and titanium in primitive formations. Hence the presence of vanadium in argillaceous iron ores. Vanadium, being chemically analogous to phosphorus, accompanies the latter in all stages of the iron manufacture. Both are found concentrated in different slags, and especially in those of the Bessemer process as modified by Thomas and Gilchrist. The steel works of Creusot, supplied from the oolite of Mazenay, produce slags exceptionally rich in vanadium, containing 1·92 per cent of vanadic acid = 1·08 metallic vanadium. From these works alone 60,000 kilos. of vanadium are obtainable yearly. The authors have succeeded in extracting the vanadium either as ammonium meta vanadiate, or in th form of new vanadic products more specially adapted for the production of aniline blacks.

Moniteur Scientifique, Quesneville.
June, 1882.

Patents on Colouring Matters taken in Berlin.—Titles and specifications of twenty-one patents for the manufacture of dyes and colours.

Contribution to the Study of Tetra-hydro-cinchonic Acid.—H. Weidel.—The author has studied the behaviour of tetra-hydro-cinchonic acid with acetyl chloride, with methyl iodide, nitrous acid, sulphuric acid, and zinc powder.

Contribution to the History of Piperidine.—M. C. Schotten.—Translated from the Berlin *Berichte*.

On Tropine.—M. G. Merling.

Petroleum and Picene.—M. J. Walter.—The author discusses the conflicting theories on the origin of petroleum. Berthelot maintains that the interior of the globe contains free alkaline metals which, in presence of carbonic acid, yield metallic acetylides, which on being decomposed by watery vapour furnish acetylene. But it has been already proved that acetylene may be polymerised, so as to produce aromatic carbides or the derivatives of marsh-gas by the absorption of hydrogen. All these reactions have been demonstrated experimentally, but the presence of alkaline metals in the interior of the globe is an unproved and improbable hypothesis. According to Byasson, the hydrocarbons of petroleum are formed by the action of water, carbonic acid, and sulphuretted hydrogen upon incandescent iron. Mendelejeff likewise admits that the action of watery vapour upon iron carbides may give rise to the formation of petroleum. To these hypotheses is opposed the absence of iron in volcanic products. Other investigators consider that petroleum is formed not synthetically, but by the decomposition of organic matter. This view is defended by the author, who regards petroleum as a product of the dry distillation of lignites.

On Carbostyrile.—MM. Friedlaender and Ostermeier.—A translation from the Berlin *Berichte*.

A New Method of Preparing Nitro-alizarine.—M. S. E. Simon.—If dinitro-oxyanthraquinone at 20 per cent suspended in water is mixed with a very little caustic soda there is formed immediately a deep red solution of the sodium salt. On prolonged ebullition the colour passes successively to a brown-red and to purple, and the liquid is evaporated until the sodium salt is precipitated in flocks. This salt on decomposition by hydrochloric acid furnishes a yellow body, which on crystallisation from acetic acid forms brilliant needles of an orange-yellow.

Condensed Milk.—From the *Journal of Applied Science*.

Presence of Fat in the Deposits of Steam-Boilers.—T. T. P. Bruce Warren.—From the *Journal of the Society of Arts*.

Processes for Tanning.—From *Iron*.

Fire-proof Paper and Impressions.—From the *Scientific American*.

The Saccharines.—Leon Cuisinier.—The author proposes to name the saccharine of M. Peligot *gluco-saccharine*, in contradistinction to its isomer obtained from maltose, which he names *malto-saccharine* or *iso-saccharine*.

Analysis of Beer.—H. Bungener.—This memoir treats merely of general preliminaries, the actual methods being promised for a future communication.

Phosphatic Manures.—M. T. Walter.—From the CHEMICAL NEWS.

Volumetric Determination of Lead.—M. Buisson.—The author's method is based on the precipitation of lead by potassium bichromate in excess; the excess of the bichromate employed is found by decomposing it in the cold by potassium iodide in presence of sulphuric acid. The reaction is almost instantaneous at common temperatures, and is complete in two or three minutes. The iodine set at liberty is determined with sodium hyposulphite as indicator: either the disappearance of the blue tint of the iodide of starch or the decolouration of iodine in carbon disulphide may be made use of. The author prefers the latter, as being much the more sensitive, for the liquid being always tinged greenish by the salt of chrome produced, the sensibility of the reaction of starch is much lessened. The standard solution of bichromate is prepared by dissolving in distilled water 14·248 grms. pure fused potassium bichromate, and making the solution up to 1 litre: 5 c.c. precipitate exactly 0·1 grm. lead. The relation between the standard liquids of bichromate and hyposulphite is thus determined. With a pipette, 25 c.c. of the bichromate liquid are taken and diluted with water to 250 c.c. Of this new solution 50 c.c. are taken and put into a stoppered bottle capable of holding 250 to 300 c.c. The liquid is then acidulated with sulphuric acid (free from chlorine and nitrous vapours), and about 0·5 grm. potassium iodide is added. When the decomposition is effected about 5 c.c. carbon disulphide or chloroform is added. The solution of hyposulphite is then added by means of a burette graduated in one-tenths of a c.c., until the rose colour of the carbon disulphide disappears: the quantity of hyposulphite added corresponds to 5 c.c. of bichromate or 0·1 grm. of lead. The solution of hyposulphite is sufficiently strong if from 35 to 40 c.c. are required to decolourise the iodine set at liberty by 5 c.c. of bichromate. The sulphuric acid should not be added in too large excess, as it might decompose the hyposulphite before the latter can act upon the iodine. In order to verify the standard of the bichromate, 0·3 grm. of pure lead is dissolved in pure, hot nitric acid, for which purpose there are required about 20 drops of acid in 5 c.c. of water. When the lead is dissolved the liquid is heated to a boil to expel nitrous vapours, and the excess of acid is saturated with potassa until a permanent precipitate is obtained, which is then re-dissolved by a few drops of acetic acid. The solution of lead is poured into a graduated flask of 250 c.c. with 25 c.c. of the bichromate solution, and distilled water enough to make up the 250 c.c. After standing for fifteen minutes, the liquid is poured upon a dry filter, and the operation is completed in the same manner as if the bichromate alone were present, as described above. The difference between the quantities of hyposulphite employed for decomposing the bichromate before and after partial precipitation by lead represents the bichromate in c.c. of hyposulphite, and consequently the lead which has been precipitated. For the assay of lead ores, the sample is ground in an agate mortar, and from 0·5 to 1 grm., or more, is weighed out according to its richness. The weighed portion is dissolved in a few c.c. of boiling hydrochloric acid, and a little potassium chlorate is then added to peroxidise the iron, and the whole is boiled for a few minutes to expel chlorine. The liquid is then saturated with an excess of caustic potassa, and the precipitate is re-dissolved in a few drops of acetic acid. It is then boiled again to precipitate the iron, and aid the solution of the lead sulphate if any has been produced. The solution is filtered, and the precipitate is washed in boiling water. To the cold liquid there are added 25 c.c. of bichromate and water, so as to make up 250 c.c. After settling for fifteen minutes, the liquid is poured upon a dry filter. 50 c.c. of the filtrate are taken and treated as described above.

Cinchotine, Hydro-cinchonidine, and Hydro-quinidine.—MM. Jobst and Bœhringer.

MISCELLANEOUS.

Institute of Chemistry.—As will be seen from the advertisement on the cover of our present issue, it is proposed to have a social gathering of the Fellows and Associates of the Institute at Birmingham, when it is hoped that arrangements will be made to enable the members to visit some of the more important chemical works in the neighbourhood. The meeting will in all probability take place on a Friday, as the most convenient day in the week for those who live in London or at a distance from Birmingham, and will give an opportunity to those who desire to do so to spend another day or so in the neighbourhood. We understand that the matter is in the hands of an energetic committee, and that the list of stewards already includes the names of many well-known chemists

South London School of Chemistry.—The following prizes have been awarded to the successful competitors at the school examinations held on the 4th, 5th, 7th, and 8th of July:—*Medals*: Senior Chemistry, Mr. Caldecot; Junior Chemistry, Mr. T. B. Tyson; Botany, Miss Mitten; Materia Medica, Mr. F. Ransome; Practical Dispensing and Pharmacy, Mr. C. L. Dillon. *Certificates*: Senior Chemistry, Mr. Bain; Junior Chemistry, Mr. F. Ransome; Botany, Mr. C. E. Harston; Materia Medica, Mr. C. E. Harston; Practical Dispensing and Pharmacy, Mr. T. B. Tyson. Certificates of Merit were also awarded to Messrs. Dowdeswell, Dillon, Hornby, Schofield, Thomas, and Thistleton.

The Status of the Scientific Chemist.—We copy the following advertisement from the *Chemiker Zeitung*, which has obtained it from the *Deutsche Zucker Industrie* (1882, p. 615):—"An academically educated chemist, fully acquainted with the manufacture (sugar), who can undertake in summer the *copper-smiths' work*, or the oversight of the *teams of draught-oxen*, is wanted for immediate engagement." Any comment would here be an anti-climax.

The Diploma Trade.—The *New York Medical Gazette* publishes the following curiosity, which we copy *verbatim et liberatim*:—"College of Physicians and Surgeons, Joplin, Mo., 5, 28, 1882. Gents,—Please send *price list* of *Doctors* and Drugist. Names by states as I want to mail *scvral thousand* Annual *catalogues* to the *profession* all over the U.S.A. and canady. I am starting an embriotic pioneer Medical College, and I must, of necessity, noise it around to the world to make it pay me. An early reply will greatly oblige, your respectfuly, &c. —J. C. PETIT, M.D., Dean."

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Carbonising.—Can any of your readers give me information as to the Berthollet system of carbonising, or give the name of any work referring to the same.—F. L. HARRIS.

THE CHEMICAL NEWS.

Vol. XLVI. No. 1184.

ELECTRIC LIGHTING BY INCANDESCENCE.*

By JOSEPH W. SWAN.

Speaking in this place on electric light, I can neither forget, nor forbear to mention, as inseparably associated with the subject and with the Royal Institution, the familiar, illustrious names of Davy and Faraday. It was in connection with this Institution that, eighty years ago, the first electric light experiments were made by Davy, and it was also in connection with this Institution that, forty years later, the foundations of the methods, by means of which electric lighting has been made useful, were strongly laid by Faraday.

I do not propose to describe at any length the method of Davy. I must, however, describe it slightly, if only to make clear the difference between it and the newer method which I wish more particularly to bring under your notice.

The method of Davy consists, as almost all of you know, in producing electrically a stream of white-hot gas between two pieces of carbon.

When electric light is produced in this manner, the conditions which surround the process are such as render it impossible to obtain a small light with proportionally small expenditure of power. In order to sustain the arc in a state approaching stability, a high electro-motive force and a strong current are necessary; in fact, such electro-motive force and such current as correspond to the production of a luminous centre of at least several hundred candle-power. When an attempt is made to produce a smaller centre of light by the employment of a proportionally small amount of electrical energy, the mechanical difficulties of obtaining a stable arc, and the diminution in the amount of light (far beyond the diminished power employed), puts a stop to reduction at a point at which much too large a light is produced for common purposes.

The often-repeated question, "Will electricity supersede gas?" could be promptly answered if we were confined to this method of producing electric light; and for the simple reason that it is impossible, by this method, to produce individual lights of moderate power.

The electric arc does very well for street lighting, as you all know from what is to be seen in the City. It also does very well for the illumination of such large enclosed spaces as railway stations; but it is totally unsuited for domestic lighting, and for nine-tenths of the other purposes for which artificial light is required. If electricity is to compete successfully with gas in the general field of artificial lighting, it is necessary to find some other means of obtaining light through its agency than that with which we have hitherto been familiar. Our hope centres in the method—I will not say the *new* method—but the method which until within the last few years has not been applied with entire success, but which, within a recent period, has been rendered perfectly practicable—I mean the method of producing light *by electrical incandescence*.

The fate of electricity as an agent for the production of artificial light in substitution for gas, depends greatly on the success or non-success of this method; for it is the only one yet discovered which adapts itself with anything like completeness to all the purposes for which artificial lighting is required.

If we are able to produce light *economically* through the medium of *electrical incandescence*, in small quantities, or in large quantities, as it may be required, and at a cost not exceeding the cost of the same amount of gas light, then there can be little doubt—there can, I think, be *no* doubt—that in such a form, electric light has a great future before it. I propose, therefore, to explain the principle of this method of *lighting by incandescence*, to show *how it can be applied*, and to discuss the question of *its cost*.

When an electrical current traverses a conducting wire, a certain amount of *resistance* is opposed to the passage of the current. One of the effects of this conflict of forces is the development of heat. The amount of heat so developed depends on the nature of the wire—on its length and thickness, and on the strength of the current which it carries. If the wire be thin and the current strong, the heat developed in it may be so great as to raise it to a white heat.

The experiment I have just shown illustrates the principle of Electric Lighting by Incandescence, which is briefly this—that a *state of white heat may be produced in a continuous solid conductor by passing a sufficiently strong electrical current through it*.

A principle, the importance of which cannot well be over-estimated, underlies this method of producing light electrically—namely, the principle of *divisibility*. By means of electric indandescence it is possible to produce exceedingly small centres of light, even so small as the light of a single candle; and with no greater expenditure of power, in proportion to the light produced, than is involved in the maintenance of light-centres 10 or 100 times greater. Given a certain kind of wire, for example a platinum wire, the 100th of an inch in diameter, a certain quantity of current would make this wire white-hot whatever its length. If in one case the wire were one inch long and in another case ten inches long, the same current passing through these two pieces of similar wire would heat both to precisely the same temperature. But in order to force the same current through the ten times longer piece, ten times the electro-motive force or, if I may be allowed the expression, electrical pressure, is required, and exactly ten times the amount of energy would be expended in producing this increased electro-motive force.

Considering, therefore, the proportion between power applied and light produced, there is neither gain nor loss in heating these different lengths of wire. In the case of the longer wire, as it had ten times the extent of surface, ten times more light was radiated from it than from the shorter wire, and that is exactly equivalent to the proportional amount of power absorbed. It is therefore evident that *whether a short piece of wire or a long piece is electrically heated, the amount of light produced is exactly proportional to the power expended in producing it*.

This is extremely important; for not only does it make it possible to produce a small light where a small light is required, without having to pay for it at a higher rate than for a larger light, but it gives also the great advantage of obtaining *equal distribution* of light. As the illuminating effect of light is inversely as the square of the distance of its source, it follows that where a large space is to be lighted, if the lighting is accomplished by means of centres of light of great power, a much larger total quantity of light has to be employed, in order to make the spaces remotest from these centres sufficiently light, than would be required if the illumination of the space were obtained by numerous smaller lights equally distributed.

In order to practically apply the principle of producing light by the incandescence of an electrically heated continuous solid conductor, it is necessary to select for the light-giving body a material which offers a considerable *resistance* to the passage of the electric current, and which is also capable of bearing an exceedingly high temperature without undergoing fusion or other change.

As an illustration of the difference that exists among different substances in respect of *resistance* to the flow of an electric current, and consequent tendency to become heated in the act of electrical transmission, here is a wire formed in alternate sections of platinum and silver; the wire is perfectly uniform in diameter, and when I pass an

* A Lecture delivered at the Royal Institution, March 10, 1882.

electric current through it, although the current is uniform in every part, yet, as you see, the wire is not uniformly hot, but white-hot only in parts. The white-hot sections are platinum, the dark sections are silver. Platinum offers a higher degree of resistance to the passage of the electric current than silver, and in consequence of this, more heat is developed in the platinum than in the silver sections.

The high electrical resistance of platinum, and its high melting-point, mark it out as one of the most likely of the metals to be useful in the construction of incandescent lamps. When platinum is mixed with 10 or 20 per cent of iridium, an alloy is formed, which has a much higher melting-point than platinum; and many attempts have been made to employ this alloy in electric lamps. But these attempts have not been successful, chiefly because high as is the melting-point of iridio-platinum, it is not high enough to allow of its being heated to a degree that would yield a sufficiently large return in light for energy expended. Before an economical temperature is reached, iridio-platinum wire slowly volatilises and breaks. This is a fatal fault, because *in obtaining light by incandescence there is the greatest imaginable advantage in being able to heat the incandescing body to an extremely high temperature.* I will illustrate this by experiment.

Here is a glass bulb containing a filament of carbon. When I pass through the filament *one unit* of current, light equal to *two candles* is produced. If now I increase the current by *one-half*, making it *one unit and a half*, the light is increased to *thirty candles*, or thereabout, so that for this one-half increase of current (which involves nearly a *doubling of the energy* expended), *fifteen times more light* is produced.

It will readily be understood from what I have shown that it is essential to economy that the incandescing material should be able to bear an enormous temperature without fusion. We know of no metal that fulfils this requirement; but there is a non-metallic substance which does so in an eminent degree, and which also possesses another necessary quality, that of *low conductivity*. The substance is carbon. In attempting to utilise carbon for the purpose in question, there are several serious practical difficulties to be overcome. There is, in the first place, the mechanical difficulty arising from its intractability. Carbon, as we commonly know it, is a brittle and non-elastic substance, possessing neither ductility nor plasticity to favour its being shaped suitably for use in an electric lamp. Yet, in order to render it serviceable for this purpose, it is necessary to form it into a slender filament, which must possess sufficient strength and elasticity to allow of its being firmly attached to conducting wires, and to prevent its breaking. If heated white-hot in the air, carbon burns away; and therefore means must be found for preventing its combustion. It must either be placed in an atmosphere of some inert gas or in a vacuum.

During the last forty years, spasmodic efforts have from time to time been made to grapple with the many difficulties which surround the use of carbon as the wick of an electric lamp. It is only within the last three or four years that these difficulties can be said to have been surmounted. It is now found that carbon can be produced in the form of straight or bent filaments of extreme thinness, and possessing a great degree of elasticity and strength. Such filiaments can be produced in various ways—by the carbonisation of paper, thread, and fibrous woods and grasses. Excellent carbon filaments can be produced from the bamboo, and also from cotton thread treated with sulphuric acid. The sulphuric acid treatment effects a change in the cotton thread similar to that which is effected in paper in the process of making parchment paper. In carbonising these materials, it is of course necessary to preserve them from contact with the air. This is done by surrounding them with charcoal.

Here is an example of a carbon filament produced from parchmentised cotton thread. The filament is not more than the 0·01 of an inch in diamenter, and yet a length of three inches, having therefore a surface of nearly the one-tenth of an inch, gives a light of twenty candles when made incandescent to a moderate degree.

I have said that, in order to preserve these slender carbon filaments from combustion, they must be placed in a vacuum; and experience has shown that if the filaments are to be durable, the vacuum must be exceptionally good. One of the chief causes of failure of the earlier attempts to utilise the incandescence of carbon was the imperfection of the vacua in which the white-hot filaments were placed; and the success which has recently been obtained is in great measure due to the production of a better vacuum in the lamps.

In the primitive lamps the glass shade or globe which enclosed the carbon filament was large, and usually had screw joints, with leather or india-rubber washers. The vacuum was made either by filling the lamp with mercury, and then running the mercury out so as to leave a vacuum like that at the upper end of a barometer, or the air was exhausted by a common air-pump. The invention of the mercury pump by Dr. Sprengel, and the publication of the delicate and beautiful experiments of Mr. Crookes in connection with the radiometer, revealed the conditions under which a really high vacuum could be produced, and in fact gave quite a new meaning to the word vacuum. It was evident that the old incandescent lamp experiments had not been made under suitable conditions as to vacuum; and that before condemning the use of carbon, its durability in a really high vacuum required still to be tested. This idea having occurred to me, I communicated it to Mr. Stearn, who was working on the subject of high vacua, and asked his co-operation in a course of experiments having for their object to ascertain whether a carbon filament produced by the carbonisation of paper, and made incandescent in a high vacuum, was durable. After much experimenting we arrived at the conclusion that *when a well-formed carbon filament is firmly connected with conducting wires, and placed in a hermetically sealed glass ball, perfectly exhausted, the filament suffers no apparent change even when heated to an extreme degree of whiteness.* This result was reached in 1878. It has since then become clearly evident that Mr. Edison had the same idea and reached the same conclusion as Mr. Stearn and myself.

A necessary condition of the higher vacuum was the simplification of the lamp. In its construction there must be as little as possible of *any* material, and there must be none of such material as could occlude gas, which being eventually given out would spoil the vacuum. There must besides be no joints except those made by the glass-blower.

Therefore, naturally and per force of circumstances, the incandescent carbon lamp took the most elementary form, resolving itself into a *simple bulb, pierced by two platinum wires supporting a filament of carbon.* Probably the first lamp, having this elementary character, ever publicly exhibited, was shown in operation at a meeting of the Literary and Philosophical Society of Newcastle, in February, 1879. The vacuum had been produced by Mr. Stearn by means of an improved Sprengel pump of his invention.

Blackening of the lamp glass and speedy breaking of the carbons had been such invariable accompaniments of the old conditions of imperfect vacua, and of imperfect contact between carbon and conducting wires, as to have led to the conclusion that the carbon was volatilised. But under the new conditions these faults entirely disappeared, and carefully conducted experiments have shown that well-made lamps are quite serviceable after more than a thousand hours' continual use.

Here are some specimens of the latest and most perfected forms of lamp. The mode of attaching the filament to the conducting wires by means of a tiny tube of platinum, and also the improved form of the lamp, are due to the skill of Mr. Gimingham.

The lamp is easily attached and detached from the socket which connects it with the conducting wires, and can be adapted to a great variety of fittings, and these

may be provided with switches or taps for lighting or extinguishing the lamps. I have here a lamp fitted especially for use in mines. The current may be supplied either through main wires from a dynamo-electrical machine, with flexible branch wires to the lamp, or it may be fed by a set of portable store cells closely connected with it. I will give you an illustration of the *quality* of the light these incandescent lamps are capable of producing by turning the current from a Siemens dynamo-electric machine (which is working by means of a gas engine in the basement of the building) through sixty lamps ranged round the front of the gallery and through six on the table. (The theatre was now completely illuminated by means of the lamps, the gas being turned off during the rest of the lecture).

(To be continued.)

ANALYSIS OF POTASH MADE FROM KYATHOURG BAMBOO.

By R. ROMANIS, D.Sc.,
Chemical Examiner to Government, British Burmah.

It has been found that teak grows best when mixed with bamboo, but as the expense of the planting is great, it has been proposed to find some useful application for the bamboo in question that would defray part of the cost of its cultivation. With this end the officers of the Forest Department have been experimenting with a view of making potash from the ashes of the bamboo.

The following is an analysis of the crude potash :—

K_2O	43·12
KCl	8·65
Na_2O	2·51
CO_2	11·96
SiO_2	12·89
SO_3	6·05
P_2O_5	4·18
Al_2O_3	1·90
H_2O	8·74
	100·00

RATIONAL METHOD FOR THE STUDY OF DYEING.

By M. DECAUX.

M. Decaux, for forty-two years head of the Chemical Laboratory of the Gobelins, and for thirty-three years sub-director of the dyes under the direction of M. Chevreul, has aimed at summarising in the most concise manner the principles which ought to guide the pupil in the art of dyeing in the order of his work. He formulates here his views in order to establish their principles.

The pupil ought at the outset to know the elements of physics and chemistry, more thoroughly if they aim at becoming managers than if they are to be ordinary workmen. They should be naturally well organised, and have the sense of sight perfect and sensitive enough to distinguish colours among themselves, both as regards intensity and tone.

As a matter of course, persons affected with the defect of vision known as colour-blindness—which consists in confounding together different colours, such as red and green—can never engage with success in the arts which work with colours.

The pupil-dyers ought to know the principles of the contrast of colours, and especially of their mixture, or at least this science, still far from general, should be taught them at the outset.

On entering upon the practice of the art, and having as a basis a more or less complete knowledge of the nature of the materials upon which they have to fix colours, they will begin with those which are simplest, matching as well as possible the patterns given them.

Red, a simple colour obtained upon wool with cochineal fixed with tartar, tin-composition, and a small proportion of alum. Their preliminary studies will have made them acquainted with the composition and the reactions of these ingredients. Blue, obtained either with iron ferrocyanides or with extract of indigo. Lastly, yellow, a simple colour like the two former, produced with weld fixed by means of alum and a very small proportion of tartar.

These three colours are the types which by their mixture from all those which the pupil will in future have to produce.

He will then pass to the dyeing of the mixed colours, which may be reduced to three, and which, in opposition to the three simple colours above mentioned, may be called binary colours—viz., orange, composed of red and yellow; green, composed of yellow and blue; and violet, composed of blue and red. Here there arise sometimes incompatibilities of the means of fixing the two colours composing the mixture. Further, the variation of the proportion of the two simple colours which enter into the binary compound colour modifies its shade and augments the difficulties.

It is proper to pass to the dyeing of a colour in all its degrees of intensity from the lightest to the most intense. This assemblage of patterns when properly got up are all equidistant from each other in point of intensities, and may be more or less numerous. Each of them may be called a shade, and the whole a series.

The first shade of a series of colour borders more or less closely upon white, according to the number of shades in the series, and the last shade in like manner approaches closely upon black.

The difficulties of this work are in the proportion and the nature of the mordant or agent used to fix the colour, and of the colour itself for producing the shade; in the temperature required for fixation; and, in certain cases, in the nature of the material, wool, or silk, which having a slight orange tint, renders light blue shades greenish, and dims the beauty of light violets.

These various difficulties which exist in the series of the simple colours, red, yellow, and blue, are augmented in those of the binary colours—oranges, greens, and violets—from the necessity of keeping the two component colours always in the same proportion, so that the series may remain always regular, preserving the same tone in their whole extent. This extent—*i.e.*, the number of shades in a series from white to black—varies with the interval which is made between two neighbouring shades, and their number will be so much the greater as these intervals are smaller.

The number of twenty shades seems most convenient, though series are sometimes made of thirty or forty shades.

When the six series are suitably made, the pupil will exercise himself in passing from each simple colour to the others, varying the proportions of the two. The red and yellow which, if mixed in proportions optically equal, yield an orange will give an orange-red if the proportion of the red is increased relatively to the yellow, and inversely an orange-yellow if the proportion of the yellow is increased relatively to the red. The intermediate tones take the names of:—

Red	R. 1, 2, 3, 4, 5
Red-orange ..	R O. 1, 2, 3, 4, 5
Orange	O. 1, 2, 3, 4, 5
Orange-yellow	O Y. 1, 2, 3, 4, 5
Yellow	Y. 1, 2, 3, 4, 5

The intermediate tones between the yellow and blue are named yellow-green, green, blue-green. Between blue

and red—violet-blue, violet, red-violet, thus returning to red through the whole circuit of the spectral colours. We may thus draw up a chromatic table, either circular or rectangular, which latter form is more convenient for observation and matching-off.

The next lesson consists in mixing, not as heretofore two simple colours in various proportions, but two complementary colours, *i.e.*, three simple colours, for the complementary of a simple colour is always a binary. Thus red, a simple colour, has for its complementary green a compound of yellow and blue. Yellow has for its complementary violet, composed of red and blue. Blue has for its complementary orange, a compound of red and yellow.

In these mixtures there appears a new phenomenon: the new colour no longer, as in the mixture of two simple colours, participates in that of each of its components. It loses its lustre, is dulled and saddened, and when the three components are in equilibrium without any of them predominating, there is a complete extinction of colour, and the result is a grey. The study of these new mixtures which the pupil will undertake will be the most interesting part of all his labours, since the beauty of the colours which he will produce will often depend on his knowledge of these phenomena. He will therefore mix two complementary colours, *e.g.*, red and green in nine proportions—nine-tenths red with one-tenth green. The result will be a red slightly lowered by the grey resulting from the mixture of the green with a portion of the red: this grey lowers the remainder of the red. The second pattern will contain eight-tenths red and two-tenths green. The proportion of grey being augmented by the neutralisation of two-tenths of the red in place of one-tenth, as in the foregoing pattern, the resulting red will be still more lowered. It will be the same increasingly in the third and the fourth, whilst in the fifth the proportions of red and green neutralising each other reciprocally, the result will be a pure grey. Still further diminishing the proportions of the red, we obtain greens less and less lowered as we approach a pure green.

The same results are obtained by mixing yellow and violet or blue and orange. Lastly, two complementary colours may both be binary. The sum of the simple colour common to both being always the same, the one having more of what the other has less, thus a red-orange is complementary of a blue-green. The yellow contained in the former colour diminishes in the same proportion as it increases in the second. It is understood that the proportions one-tenth, two-tenths, &c., are neither ponderable nor volumetric, but simply optical. The passages through grey from one complementary colour lead naturally to the last patterns to be executed by the pupils who will have to produce a series of greys by the mixture of three simple colours. This series, when well drawn up, having its shades equally distant from each other, and all of a perfect grey without the predominance of any of its component colours, is the most difficult task which the dyer can undertake, and he will have the merit of obtaining a tone, the resistance of which to atmospheric injury will participate in that of its component colours.

This sum total of work, executed with different colouring matters upon different materials, will constitute the art of the dyer as derived from rational principles, which the dyer ought to comprehend fundamentally, and to carry out instinctively in practice.—*Bulletin de la Société d'Encouragement.*

Researches on the Formation of the Ptomaines.—MM. Paterno and Spica.—From the experiments of the authors it appears that the same substances, or substances similar to those known as ptomaines or cadaveric alkaloids, may be extracted from the animal fluids in a physiological condition, and before entering into putrefaction. This does not exclude, evidently, the formation of a new series of these substances.—*Moniteur Scientifique.*

RESEARCHES ON THE SUBSTITUTED BENZYL COMPOUNDS.

The Synthesis of Anthracene and Phenanthrene from Ortho-brom-benzyl-bromide.*

By C. LORING JACKSON and J. FLEMING WHITE.

(Concluded from p. 45.)

Discovery and Synthesis of Phenanthrene.

It is highly probable that Fritzsche,† in 1867, encountered phenanthrene in studying the higher fractions of coal-tar with his reagent, as he describes a hydrocarbon melting near 100°; this observation was entirely overlooked, however, and we owe the first definite statements about phenanthrene to Fittig,‡ who announced its discovery in August, 1872: but his preliminary notice of it was so imperfect that Glaser, who discovered it at about the same time, sent it to Graebe§ for investigation as a new hydrocarbon. In 1873 three independent tolerably complete accounts of it appeared almost simultaneously in the *Annalen der Chemie*; these were by Fittig and Ostermayer,‖ by Graebe,¶ and by Hayduck.**

In Graebe's article the synthesis of phenanthrene by passing stilbene or dibenzyl through a red-hot tube is described, whereas Dreher and Otto,†† who tried the same experiment in 1870, before the discovery of phenanthrene, naturally overlooked it.

In the following year Graebe‡‡ added toluol to the substances which form phenanthrene under these conditions; and Barbier§§ announced that Fritzsche's phosene (see p. 44) was a mixture of anthracene and phenanthrene, since he succeeded in getting the characteristic test, brown plates, with Fritzsche's reagent (dinitro-anthraquinone) from such a mixture. Armed with this test, he then proceeded to examine the anthracenes from various syntheses, and found phenanthrene in those made by the action of heat on styrol and benzol, ethylene and benzol, benzyl-toluol, phenyl-xylol, and diphenyl-methane; also in the anthracene made from benzyl-chloride by heating with water, and in that from natural alizarine by reduction with zinc-dust; as in all these cases the phenanthrene could not be detected by any other test except Fritzsche's reagent, there seems good reason for receiving these results with caution, especially as he himself has proved by direct experiment‖‖ that anthracene cannot be converted into phenanthrene by heat. By passing a mixture of ethylene and diphenyl through a red-hot porcelain tube, however, he obtained a large quantity of phenanthrene, and also by heating liquid ditolyl or stilbene to dull redness in a sealed tube. Finally, Kramers¶¶ found a trace of phenanthrene among the products from passing phenol through a yellow-hot tube.

Constitution of Anthracene and Phenanthrene.

Dumas and Laurent, in their first article on anthracene, considered it a polymerised naphthalene. Anderson, after establishing the formula, called attention to the fact that anthracene and anthraquinone differed from stilbene and benzyl only by two atoms of hydrogen in each case. Berthelot, in 1867, on account of its formation from toluol at a red heat, gave it the formula—

$$C_6H_4[C_6H_4C_2H_2],^{***}$$

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* Presented to the American Academy. Communicated by the Authors.

† *Zeit. für Chemie*, 1867, 293.

‡ *Ber. Deut. Chem. Ges.*, 1872, 933.

§ *Ibid.*, 968.

‖ *Ann. Chem. Pharm.*, 166, 361.

¶ *Ibid.*, 167, 131.

** *Ibid.*, 167, 177.

†† *Ibid.*, 154, 176.

‡‡ *Ber. Deut. Chem.*, 1874, 48.

§§ *Comptes Rendus*, 79, 121, 650, 810; also *Ann. Chim. Phys.*, series 5, 7, 515.

‖‖ *Ann. Chim. Phys.*, 5, 7, 515.

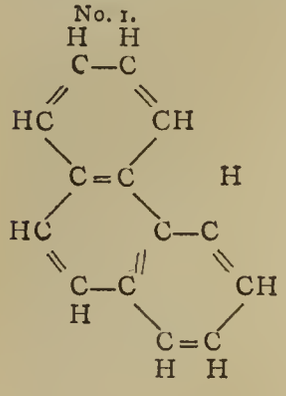
¶¶ *Ann. Chem. Pharm.*, 189, 132.

*** Calculated to modern atomic weights.

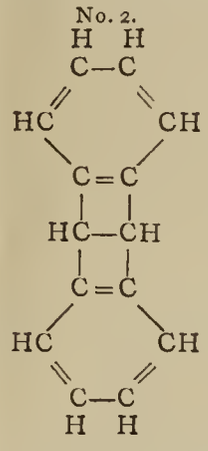
which he showed later in the same year was supported also by Limpricht's synthesis, and his own decompositions of anthracene* with hydriodic acid; he considered it an "acetylo-diphenylene," but pointed out the fact that while the calculated boiling-point of this substance should be 310° to 320°, the boiling-point of anthracene is in reality 360°.

In 1870, Graebe and Liebermann proposed two formulæ for anthracene, giving the preference to No. 1, on the

No. 1.



No. 2.



ground of the syntheses by Limpricht from benzyl-chloride, and Berthelot from styrol and benzol; also because this formula is like that of naphthalene, which they show is allied to anthracene in many respects; but these arguments were overturned in 1872 by the discovery of phenanthrene, which not only resembled naphthalene more closely than anthracene did, but yielded diphenic acid and other undoubted derivatives of diphenyl, and was therefore entitled to the first formula, leaving the second for anthracene. This arrangement of the formulæ was confirmed by Van Dorp's synthesis of anthracene from benzyl-toluol, and by some experiments by Graebe,† which showed that phenanthrene-quinone gave diphenyl on distillation with soda-lime, while anthraquinone gave benzol and a very little diphenyl, indicating that there is no direct union of the rings in the latter.

Finally the syntheses from phthalic acid, and the formation of phthalic acid by oxidation, or the action of sulphuric acid‡ on anthraquinone, established without doubt the ortho-position of the connecting atoms of carbon in one of the benzol rings of anthracene, which was still further confirmed by the syntheses from liquid benzyl-toluol and β-benzoyl-benzoic acid.

At the end of 1873, therefore, the second formula had been universally adopted as that of anthracene, although the position of the two connecting atoms of carbon in one of the benzol rings had not been determined, and the researches of following years, while confirming the points already established, threw no more light on this subject.§

With phenanthrene the case is different, as the proof of the ortho-position of the two additional atoms of carbon has not been neglected. In 1878, Schmitz‖ argued that this was probably the constitution from the fact that diphenylene-ketone and diphenyl-carboxylic acid were completely destroyed by oxidation; while somewhat later in the same year the point was proved by Schultz,¶ and by Anschütz and Japp,** almost simultaneously. Schultz did this by converting Griess's meta-diamido-diphenic†† acid (made by the reduction of meta-nitro-benzoic acid with tin and hydrochloric acid) into di-iod-diphenic acid, and reducing this to a diphenic acid, which he proved was identical with that from phenanthrene (a proof which he did not make perfectly satisfactory till a later paper,* in 1879). Anschütz and Japp oxidised the sodic salt of the phenanthrene-sulpho-acid with potassic permanganate, and obtained phthalic acid as the only product, whereas, if phenanthrene were not a diortho-compound, isophthalic or terephthalic acid must also have been formed.

In 1879, Merz and Weith† proposed a new formula for phenanthrene,—

$$C_6H_4=C-C=C_6H_4,$$

founded on the fact that they obtained invariably per-chlor-benzol instead of perchlor-diphenyl by the exhaustive action of chlorine upon it; the formation of diphenic acid would then be due to an atomic transformation during the process of oxidation. This hypothesis, however, can hardly be considered as throwing doubt on the constitution of phenanthrene until supported by additional facts, especially since Japp‡ has shown by the formation and properties of the β-phenanthrene-carboxylic acid that the C_2H_2 group behaves as if it were part of a benzol ring.

At present, then, the constitution of phenanthrene must be considered as settled, while it still remains to prove the position of the two connecting atoms of carbon on one of the benzol rings in anthracene.

Action of Sodium on Ortho-brom-benzyl-bromide.

In the hope of settling the constitution of anthracene we have studied the action of sodium on ortho-brom benzyl-bromide, since this might lead to the formation of a hydride of anthracene by the union of two molecules, the side-chain of each being joined to the ring of the other, and of phenanthrene-dihydride if the two side-chains and the two rings were united. As these two reactions were likely to take place side by side, we expected that our product would consist of a mixture of these two hydrocarbons.

Ortho-brom-benzyl-bromide dissolved in anhydrous ether§ was warmed with sodium for some days, fresh shavings of sodium or sodium shot‖ being added from time to time, until the bright surfaces were no longer tarnished. The greater part of the sodium was then removed, and, after treatment with dilute alcohol to destroy the remainder, the product of the reaction thoroughly washed with water; the yellowish viscous mass thus obtained was oxidised with chromic anhydride, and upon subliming the product, after removing the portions soluble in water and sodic hydrate, yellow needles were obtained which melted at 273°, and gave with zinc-dust and sodic hydrate a red colour; they were therefore *anthraquinone.*

0·5745 gr. of the substance gave on combustion 1·7000 grs. CO_2 and 0·2180 gr. H_2O.

	Calculated for $C_{14}H_8O_2$.	Found.
Carbon	80·75	80·67
Hydrogen	3·84	4·21

The anthraquinone was further converted into the bromine compound, which by fusion with potassic hydrate yielded alizarine.¶

A second portion of the ortho-brom-benzyl-bromide treated with sodium, and afterward freed from it in the same way, was distilled with steam for a long time, a white substance passed over, solidifying in part in the

* *Bull. Chim. Soc.*, 9, 295.
† *Ber. Deut. Chem. Ges.*, 1873, 63.
‡ Weith and Bindschedler, *Ibid.*, 1874, 1106.
§ Anschütz (*Ibid.*, 1878, 1213) made diphenylene-ketone by heating anthraquinone with calcic oxide, but proves in the same paper that this reaction cannot be used as an argument in regard to the position of the C_2H_2 group in anthracene.
‖ *Ann. Chem. Pharm.*, 193, 115.
¶ *Ann. Chem. Pharm.*, 196, 1; *Ber. Deut. Chem. Ges.*, 1878, 215.
** *Ber. Deut. Chem. Ges.*, 1878, 211.
†† *Ibid.*, 1874, 1609.

* *Ber. Deut. Chem. Ges.*, 1879, 235.
† *Ibid.*, 677.
‡ *Ibid.*, 1880, 573.
§ When toluol was used in place of ether, the reaction ran so slowly that even after boiling for several days the sodium was but little affected.
‖ The sodium shot was made by melting sodium under toluol, and shaking (Wislicenus, *Ann. Chem., Pharm.*, 186, 212). It seemed to be not so effective as thin shavings of sodium.
¶ A preliminary notice of the work up to this point was published, *Ber. Deut. Chem. Ges.*, 1879, 1965.

condenser, which was proved to be dibenzyl by its odour, its melting-point 52°, and the following analysis :—

0·2435 gr. of the substance gave on combustion with $PbCrO_4$* 0·8240 gr. CO_2 and 0·1700 gr. H_2O.

	Calculated for $C_{14}H_{14}$.	Found.
Carbon..	92·31	92·27
Hydrogen	7·69	7·75
	100·00	100·02

No anthracene-dihydride could be found in the distillate with steam, although it was carefully searched for.

The residue left in the flask, after the distillation with steam, was a yellow viscous mass, which can be most conveniently purified after distillation *per se*, as this destroys the greater part of the viscous substances containing bromine, which render the extraction with a solvent toilsome and unsatisfactory. The distillate, which passed over without a pause from 260° to redness, consisted of a solid mixed with oil, and had a very disagreeable rank smell, different from that of the undistilled substance. The less volatile parts of the distillate were easily converted by washing with alcohol and ether into white plates with a blue fluorescence, which melted at 212°, and were therefore *anthracene*. The residue left by evaporation of the alcoholic washings consisted of dibenzyl, a brown viscous substance containing bromine and a small amount of a yellow oil; it was tested for phenanthrene by oxidation with chromic anhydride in glacial acetic acid solution, and treatment of the product, after it had been freed from chromic compounds with water, and from acids by weak sodic hydrate, with warm acid sodic sulphite; the solution thus formed was filtered, acidified with hydrochloric (better nitric) acid, and allowed to stand for some time, when it deposited a yellow precipitate, which melted at 198°, and was therefore *phenanthrene-quinone*. For further confirmation it was tested, according to Laubenheimer,† as follows: A little of the substance was dissolved in about 5 c.c. of glacial acetic acid, a few drops of toluol, and 8 to 10 drops of sulphuric acid were added, and the mixture allowed to stand over night. It was then poured into water, which, shaken with ether, imparted to it a deep claret-red colour, exactly like that obtained from pure phenanthrene-quinone under the same conditions.

In a third experiment 20 grms. of ortho-brom-benzyl-bromide were treated with sodium for nearly a month in the way already described, but, instead of adding water at once to the product, the organic matter was extracted from the sodium and sodic bromide as far as possible with ether and benzol, in order to avoid the reducing action of the hydrogen set free by water. The residue insoluble in these solvents was finally treated with water, and the small amount of organic matter thus obtained added to that at first extracted. The amount of dibenzyl in this product was notably smaller than in those which had been treated directly with water. In a weighed portion an attempt was made to determine the amount of phenanthrene, by adding picric acid to a strong alcoholic solution, but no crystals of the picric acid compound of phenanthrene separated; the solution was therefore evaporated, and in this way a few red crystals were obtained, which had the form of the compound of anthracene with picric acid, and melted in the crude state near 168° instead of at 170°; the quantity was too small to admit of purification. The formation of the anthracene compound, which is decomposed by alcohol, apparently from an alcoholic solution, can be explained by the supposition that it was not formed until the alcohol had evaporated, leaving the anthracene and picric acid dissolved in the oily impurities. In point of fact, it was obtained by imitating the above conditions; that is, evaporating an alcoholic solution of anthracene and picric acid, to which a few drops of toluol had been added. The experiment would seem to show that phenanthrene as such does not exist in the original product.

To meet the objection which might be urged, that the anthracene obtained in the second experiment was not formed directly by the action of sodium on the ortho-brom-benzyl-bromide, but during the distillation of the viscous mass, which resembled the substance obtained by Zincke both from his reaction and the action of water at high temperatures on benzyl-chloride, another portion was treated with ether and hot alcohol, which removed a yellow oil and left *anthracene* identified by crystallising in white plates melting at 210°. The yellow oil contained either phenanthrene or its dihydride,* as it gave phenanthrene-quinone by oxidation, but we were unable to determine which of these substances was present on account of the small amount at our disposal. We are therefore in doubt as to the way in which the phenanthrene occurs in our product; for, on the one hand, we could not obtain the picric acid compound either from the original product or the yellow oil, while, on the other, a substance crystallising in plates melting between 170° and 190°, which has appeared more than once in the course of this work as an intermediate product in the purification of the anthracene, yields on oxidation anthraquinone and phenanthrene-quinone, and seems therefore to be a mixture of the two free hydrocarbons.

No anthracene-dihydride could be found in any of the products, nor have we succeeded in detecting benzyl-toluol or ditolyl, although it is highly probable that they were formed in addition to the dibenzyl; but the acids resulting from the oxidation appeared in such small quantities, and so contaminated with a brown impurity formed from the viscous brominated substance, that it was impossible to obtain any definite result from them. The viscous substances, too, containing bromine, which were the principal products of the reaction, have resisted thus far all our efforts to bring them into a form suitable for analysis, but we hope to return to this part of the subject hereafter.

Finally the following quantitative results were obtained :—

Organic product from 20 grs. ortho-brom-benzyl-bromide	10·85 grs.
Calculated product if free from bromine.. ..	7·12 ,,
Bromine not removed by the sodium	3·73 ,,
Bromine in 20 grs. ortho-brom-benzyl-bromide	12·88 ,,
Bromine removed as bromide of sodium ..	9·71 ,,
Bromine not removed by the sodium	3·17 ,,

The "bromine removed as bromide of sodium" was determined by precipitating 7·727 grs. of the wash-water with argentic nitrate, which gave 1·482 grs. of argentic bromide. As the weight of the wash-water was 119 grs. this corresponds to the result given above. The two determinations of the amount of bromine not removed by the sodium agree as closely as could be expected when the losses resulting from the repeated extraction and washing of the viscous organic products are taken into account.

75·4 per cent of the whole amount of bromine contained in the ortho-brom-benzyl-bromide was therefore removed by the sodium.

Determination of the Amount of Anthracene by Luck's† Method.—1·04 grs. of the product, oxidised, first with chromic anhydride dissolved in glacial acetic acid, and afterward with an alkaline solution of potassic permanganate, gave 0·158 gr. of anthraquinone, corresponding to

* Owing to the ease with which the substance sublimes, great difficulty was encountered in getting a satisfactory combustion.

† *Ber. Deut. Chem. Ges.*, 1875, 224.

* Phenanthrene-dihydride has never been prepared with certainty although Barbier (*Comptes Rendus*, 79, 121) thought it was formed by the reduction of phenanthrene with sodium amalgam.

† *Zeit. Anal. Chemie*, 1873 347; 1874, 251.

0·135 gr. of anthracene, that is, 1·409 grs. from the 20 grs. of ortho-brom-benzyl-bromide used, or 19·78 per cent of the theoretical yield.

Determination of the Amount of Phenanthrene.—2·44 grs. of the original product, oxidised carefully by adding a strong aqueous solution of chromic anhydride to a hot solution of the substance in glacial acetic acid as long as a drop of the oxidising agent made the liquid boil,* on extraction of the product with acid sodic sulphite and acidification with nitric acid, yielded 0·05 gr. of phenanthrene-quinone, which corresponds to 0·0428 gr. of phenanthrene; that is, from 20 grs. of ortho-brom-benzyl-bromide 0·190 gr., or 2·66 per cent of the theory. The amount of phenanthrene actually formed must have been somewhat larger than this, as some of the quinone was undoubtedly destroyed by the chromic anhydride—in fact, the operation can hardly be called a quantitative one.

From the work described above, it appears that 20 grs. of ortho-brom-benzyl-bromide yielded,—

Total organic product	10·850 grs.
Anthracene	1·409 ,,
	9·441 ,,
Phenanthrene	0·190 ,,
	9·251 ,,
Dibrom-dibenzyl, or its isomers, calculated from 3·17 grs. of unremoved bromine	6·738 ,,
Undetermined, containing phenanthrene, dibenzyl, benzyl-toluol, and ditolyl ..	2·513 ,,

Summary of Results.

Ortho-brom-benzyl-bromide when treated with sodium yields anthracene (identified by its melting-point 212°, the formation of anthraquinone, melting-point 273°, and of alizarine; 19·78 per cent of the theoretical yield); and phenanthrene (identified by the melting-point of its quinone 198°, and by Laubenheimer's test; 2·66 per cent of the theoretical yield). Certainly part, and probably all, of the anthracene occurs in the free state; no anthracene-dihydride could be found. Our experiments leave us in doubt as to the way in which the phenanthrene occurs. Dibenzyl was also obtained, an oil possibly benzyl-toluol or ditolyl, and a viscous substance containing bromine.

By this synthesis of *anthracene* from ortho-brom-benzyl-bromide, it is proved that the *two connecting carbon atoms are attached to each ring in the ortho-position*, and thus the last doubt about the constitution of anthracene is removed.

The synthesis of phenanthrene, while it confirms the ortho-attachment of the two additional atoms of carbon, proves nothing either for or against the formula recently proposed by Merz and Weith.

The publication of the preliminary notice of this work, already mentioned, drew out an article from Von Pechmann,† describing work done at about the same time as ours, in which he applies to anthracene the ingenious method contrived by Graebe for determining the constitution of naphthalene as follows: Brom-ortho-benzoyl-benzoic acid, prepared by the action of brom-phthalic acid on benzol in presence of aluminic chloride, was converted into brom-anthraquinone by heating with sulphuric acid, which on fusion with potassic hydrate gave erythroxy-anthraquinone, and, as this when oxidised yielded phthalic acid, the conclusion drawn from our experiments that anthracene is a diortho-substance is confirmed by his work.—*American Chemical Journal.*

* Liebermann and Hormann, *Ber. Deut. Chem. Ges.*, 1879, 591.
† *Ber. Deut. Chem. Ges.*, 1879 2124.

ANNUAL RECORD OF PUBLISHED SCIENTIFIC WORK.

The following letter has been circulated by Mr. W. J. Sollas, Professor of Geology in University College, Bristol:—

"Sir,—I beg to bring before your notice a scheme for obtaining in a more effectual manner than hitherto a complete Annual Record of published Scientific Work. The disadvantages which attend the present absence of all system, notably the extravagant waste of time and labour involved, are so apparent as scarcely to need pointing out. That two Zoological Records should appear independently of one another, one at Naples and the other in London; that there should exist at least five or six Chemical Records all covering very much the same ground; more than one Geological Record, and in Physics no Record at all, at least in England; that some of these Records should be several years overdue, and others wanting in completeness, are anomalies which show the pressing need for reform.

"What is urgently required is some plan by which an Annual Record in each branch of Science may be obtained by the co-operation of scientific men all over the world. This would be most easily accomplished if—

(I.) Each nation furnished a Record of its own work, and its own only.

(II.) Each nation received the Records of every other nation in exchange for its own.

"Each nation being thus put in possession of Records from every part of the world would have but to classify and translate them in order to obtain, written in its own language, a complete systematic Record of the world's annual work in Science.

"To carry out this scheme would be required—

(I.) National Committees.
(II.) An International Congress.

"(I.) *The National Committees.*—These would each consist of a number of sections; one for each branch of Science, according to a classification, to be subsequently agreed upon. Their functions would be—

(i.) To produce the National Records.
(ii.) To receive and transmit Exchanges.
(iii.) To arrange for Translations.
(iv.) To superintend the Combination of the separate Records into a whole.

"(i.) The mode of obtaining a record of the work done in each country need not be discussed here, as it is a matter of detail which each Committee might best be left to determine for itself, aided in some respects as it might be by discussion in Congress.

"(ii.) The management of exchanges is a simple matter, merely involving the keeping by each Committee of a list of the head-quarters of all the rest, as well as the trouble and expense of postage.

"(iii.) The arrangements for translation would not be difficult. The translators would of course need to have some knowledge of science, if they were not actually scientific men, but there would probably be little difficulty in obtaining them, especially when it is considered that the main bulk of our scientific literature is furnished by English-, French-, and German-speaking peoples. The case is different with Russian and little-spoken languages, but the extra expense in procuring translators for them would be well compensated for by the wider recognition which the work published in these languages would obtain.

"iv. Finally, the union of the various Records into a whole remains to be considered, but this is so technical a matter, and can be accomplished in so many various ways, that it need not be discussed here. Each Committee would probably adopt a plan of its own, and probably no two plans would be exactly the same.

"(II.) *The International Congress.*—This would consist of representatives from each of the different National Committees. It would aim at securing so much uniformity as would be necessary for the successful working of the scheme, without interfering with the liberty of the Committees; and it would afford an opportunity for the interchange of ideas. Such a Congress might indeed be made a part of an International Association for the Advancement of Science,—an organisation for which the scientific world seems now to be waiting.

"The advantages of some such scheme as that just sketched out are great and obvious. It saves labour both by subdivision and by preventing the same thing from being done twice over or oftener, and hy this economy is enabled to secure the maximum of efficiency at the minimum of expense.

"In conclusion, certain difficulties remain to be considered, and first with reference to expense. For it may be argued that a plan so extensive in its operations, involving so many combinations and so much labour, could not succeed unless directed by the most business-like management; and that such management could not be obtained for nothing, nor for a small sum. A post ill-paid is usually ill-served; and though it often happens that a small pecuniary payment is compensated for by payment of a quite different kind, yet that would evidently not be the case here. The officers of a recording system would have a thankless task, and would require to be paid for their labours. The saving effected by co-operation would, however, in some cases furnish a sum quite large enough for the adequate remuneration of abstractors, translators, editors, managers, and all concerned; in others it would possibly require to be supplemented by grants of money from Government or learned Societies. No doubt if the general scheme comes to be considered fully this question of expense will lead to another, and that is the rights of existing recording organisations. But the difficulties which this question would introduce should be capable of being met. For one thing it would obviously be to the advantage of the National Committees to make use, as far as possible, of the experience and organisation of existing corporations. These indeed would continue their work, though it might be somewhat changed in character and carried on under altered conditions.

"I intend to bring this scheme, worked out in greater detail, before the next meeting of the British Association for the Advancement of Science, but venture meanwhile to submit this outline to you in the hope of receiving suggestions, raising discussion, and if possible of obtaining your influence and support.

"University College, Bristol,
"July 24, 1882."

PROCEEDINGS OF SOCIETIES.

THE SOCIETY OF CHEMICAL INDUSTRY.

The first Anniversary Meeting of this prosperous Society was held on the 5th ult. in the Chemical Theatre, Owens College, Manchester, under the presidency of Professor Roscoe. There was a large attendance of Members, among whom we particularly notice the presence of Professors Abel and Huntington, Messrs. Peter Spence, Ludwig Mond, G. E. Davis, E. K. Muspratt, and Dr. Hewitt. The progress of the Society has been most satisfactory. The number of members has risen to 1250, including a goodly number of the representative men of British chemistry, both pure and industrial. Two local sections have been formed—the Metropolitan, under the presidency of Prof. Abel, and the West Lancashire (Widnes, St. Helens, &c.), established by Mr. E. K. Muspratt. During the past year a Committee on the Patent Laws has been appointed, and has held various meetings in the hope of this important subject being taken up by the Government. We learn that the majority of this Committee agrees substantially with the bill drawn up by the Society of Arts, and introduced into Parliament by Sir John Lubbock. Mr. Chamberlain, it appears, is about to bring in a bill on the same subject on the part of the Government, though when this will occur it would be very hazardous to predict.

Prof. Roscoe again referred at length to a most serious subject dealt with in his presidential address last year,—the fact that though the greater part of the raw materials, benzol, anthracene, &c., used in the manufacture of coal-tar colours is produced in this country, we yet import from Germany and Switzerland by far the largest quantity of the colours we consume, and thus lose the profit of an industry of about three millions sterling which should properly be ours. We have, in fact, almost every natural advantage for this manufacture. We have cheaper fuel and easier communication than our rivals; we produce more coal-tar than any other country in Europe, and none of the accessory materials are rendered dearer by fiscal regulations. Yet, in spite of all this, we are in effect unable to compete with Switzerland, which has to import its raw materials and to export its finished products by long and costly land- or river-transit! Making all due allowance for the circumstance that Switzerland has no patent laws, and that a manufacturer there may if so disposed pirate the inventions of other countries, whilst a foreigner may patent his processes here without any intention of working them on British ground, the one great cause of our comparative inferiority in the colour is too plain to be mistaken. Says Professor Roscoe—and we entirely agree with him—"The chief superiority which the German and Swiss undoubtedly possess over the English colour makers is to be sought in the thorough appreciation on the part of the foreigners of the value of, and the necessity for, scientific training and knowledge of the highest type in the conduct of their business. The German and Swiss colour maker—and to a great extent the same thing must be said of German and Swiss manufacturing chemists in general—is not content to manufacture a series of well-known products; he must constantly bring out novelties, and for this purpose he and his chemist must be educated up to the level of the science of the day. He must be able to understand and apply the discoveries of the purely scientific chemist, for these form the foundations of his trade." The necessity for such training, we are reminded, was long ago proclaimed by Liebig:—"It has taken a long time to convince technical men of the fact that they are bound to acquire the highest possible scientific education if they wish to understand their processes, and if they desire to start new manufactures and meet the ever-increasing demand for novelties."

Prof. Roscoe enforced his argument by an account of the colour works of Messrs. Bindschedler and Busch, of Bâle. Here the director is a thoroughly educated chemist, cognisant of and able to make use of the researches produced in the scientific laboratories of the world. Under him are three scientific chemists, to each of whom is entrusted one of the three departments into which the works are divided. These head chemists have been thoroughly trained at the Polytechnic School at Zurich, and each has several assistants under him. All these have had a thorough scientific education at a German University or in one of the Polytechnic Schools, such as those of Zurich, Aix-la-Chapelle, &c. Directly under these scientific assistants come the common workmen, who are simply machines carrying out the dictates of a higher intelligence. There are consequently, it would appear, no foremen who have risen from the ranks, and who have a rule-of-thumb knowledge of some particular part of the process. There are no fewer than ten well-fitted experimental laboratories, in which the head chemists and their assistants carry on investigations affecting either the production of new colours or the more economical manufacture of the old ones. "No sooner do the

results of any purely scientioc research appear which may possibly yield practical results than the works' chemist scrutinises them, repeats them under modified conditions, so as at last to bring them within the limits of financial success. At some of the larger works, such as those of Hoechst and Ludwigshafen, the staff of well paid and thoroughly scientific chemists numbers from thirty to forty! This is a very great contrast to the state of things still too prevalent in England. In many works there is no scientific chemist at all, whilst in others we find one, whose time is wholly taken up with mere routine work, and from whom a degree of speed is demanded in analyses, &c., quite incompatible with accuracy, and which by fatal necessity leads to "cooking." Professor Roscoe, in closing his address, declares that the Germans and Swiss are before us—"Not only in the means of obtaining the highest technical training in their numerous universities and polytechnic schools, but what is *more to the point*, in the general recognition of the value and importance of such training for the successful prosecution of any branch of applied science." It must be remembered especially that the proprietors of such works are not, as too often with us, mere capitalists, or possessors of a bare routine knowledge of the business. They are, in the majority of cases, scientifically educated chemists who, if not personally engaged in research, can yet appreciate the work or even the suggestions of others.

A somewhat similar line of thought was worked out in a paper read by Mr. O'Neill on the "Chemistry of Calico Printing." He stated that many houses of the second class managed to get along without any skilled chemist, or even without a laboratory in which experiments could be made or colours tested. This lack of knowledge, it was contended, was a source of much loss. "It is impossible under such circumstances to determine whether or not colours, &c., supplied are genuine, and goods are often damaged in consequence. The impossibility of controlling the supply of drugs, from want of acquaintance with them, often leaves employers in the hands of dishonest servants."

It appears that certain prints had been sent in for exhibition by firms in the Lancashire district, and these were compared with some specimens of the work of M. Thierry-Mieg, of Alsace. On careful examination it was admitted that our home manufacturers had yet something to learn before they can produce the quality shown in the prints from Alsace. Indeed it is no secret to those connected with calico-printing that some of the more artistic patterns, especially those furnished by Continental designers, have to be either modified or abandoned in this country because their execution is found here practically impossible. No one surely can contend that this is a state of things with which we as a nation—and as a nation whose very existence turns upon industrial and commercial pre-eminence—ought to rest satisfied. One thing is at least certain: our rivals show no disposition to rest satisfied with what they have already effected. The Chemical News has long preached these lessons to inattentive hearers, and has sometimes been accused of a perverse disposition to undervalue British talent, skill, and practical utility. It is something to find our opinion now endorsed by the majority of those most interested and best able to judge.

Industrial Conditions of the Application of Cold for the Destruction of the Germs of Parasites in Alimentary Substances.—F. Carré.—Since M. Bouley's important communication concerning the action of cold on the trichinæ, it has become important to ascertain the economic conditions of the question. Using the ammonia machine, the cost of treating 1000 kilos. of meat is 8 francs, or rather less than 0·01 franc per kilo. M. Bouley has disproved the common prejudice that frozen meat enters into putrefaction immediately after thawing.—*Comptes Rendus.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 2, July 10, 1882.

Certain Hydrates formed by Pressure and Release. MM. L. Cailletet and Bordet.—On compressing hydrogen phosphide in presence of water in the tube, which the first-named chemist has used in his experiments on the liquefaction of gases, and suddenly reducing the pressure, there is formed a white crystalline body which in a moment lines the inside of the tube. On completely removing the pressure this newly-formed body is dissociated. The compound obtained is probably a phosphonium hydrate. An apparently different body is obtained by treating a mixture of equal volumes of carbon dioxide and hydrogen phosphide in the same manner. Another compound is obtained from a mixture of hydrogen phosphide and carbon disulphide in presence of a little water. Others are formed from hydrogen sulphide and water, and from ammoniacal gas in presence of a saturated solution of this gas. The authors reserve to themselves the further examination of these compounds.

Conditions of Achromatism in the Phenomena of Interference.—A. Hurion.—This memoir does not admit of useful abstraction.

Apparatus for Registering in a Continuous Curve the Disengagement or Absorption of Gases, particularly those which Result from the Phenomena of Fermentation and of Respiration.—P. Regnard.—This memoir cannot be intelligibly reproduced without the two accompanying illustrations.

Reply to M. Berthelot's Paper "On the Electromotive Force of a Zinc-Carbon Element."—D. Tommasi.—It has been hitherto admitted that in any element the nature of the positive electrode had no influence on its electromotive force provided that such electrode was not attacked by the exciting liquid. It appears, therefore, that the increase of electromotive force which the author has shown in the zinc-carbon element is a novel fact and not without a certain scientific interest. It is not surprising that M. Berthelot has found by means of M. Mascart's electrometer that a zinc-carbon has an electromotive force greater than that of a zinc-platinum. It would have been very strange if M. Berthelot's determinations had proved the contrary. All the experiments which this *savant* has described (*Comptes Rendus*, July 3, 1882) in no way militate against the author's researches.

Basic Salts of Manganese.—Alex. Gorgen.—An account of three double salts formed by basic manganese sulphate with potassium, ammonium, and sodium sulphates.

Action of Bromine upon Quinoleine and Pyridine.—E. Grimaux.—The author's object is to prepare the addition-products of bromine to quinoleine and pyridine and to compare them with those furnished by cinchonine.

Researches on the Curves of Solubility in Water of the Varieties of Tartaric Acid.—E. Leidie.—The coefficient of solubility in water of the varieties of tartaric acid may be represented in a general manner by a function of the temperature:

$$\frac{ds}{dt} = A f(t),$$

in which A is a coefficient peculiar to each variety. The author gives in a table the solubilities of dextro- and levo-tartaric acid, of anhydrous and of hydrated racemic acid at 0°, 5°, 10°, &c., up to 100°.

Botanical, Chemical, and Therapeutic Researches on the Globulariæ.—E. Heckel, J. Mourson, and F.

Schlagdenhauffen.—From the leaves of these plants the authors have obtained tannin, a colouring-matter, free and combined, cinnamic acid, and a glycoid, which Walz has named globularine, and which yields a single decomposition product globularetine. This latter substance, on treatment with caustic alkalies in heat, is converted into cinnamic acid.

Presence of a Glycol in Wine.—A. Henninger.—The substance in question is a butyl glycol.

Analyses of Waters from the Isthmus of Panama.—M. Aillaud.—The only remarkable feature in these waters is the presence of ruthenium in that of the Rio Grande.

Moniteur Scientifique, Quesneville.
June, 1882.

Alkaloids of the Cinchonas.—M. A. Hesse.—These two memoirs are translated from the Berlin *Berichte*.

Determination of the Alkaloids of the Cinchonas.—Dr. J. E. Vrig.—From the *Journal de Pharmacie et de Chimie*.

Determination of Phosphorus in Iron and Steel.—E. Agthe.—See vol. xlv., p. 284.

A New Alkalimetric Indicator: Determination of Carbonates in Caustic Solutions.—Prof. G. Lunge.—The substance of this paper has been already inserted.

Analysis of Wines.—Drs. Nessler and Barth.—From the *Zeitschrift für Analytische Chemie*.

Preparation of Sulphuryl Chloride.—Hans Schulze.—From the *Journal für Praktische Chemie*.

Certain Indigenous Drugs of India.—Prof. C. J. H. Warden.—From the Chemical News.

Preparation of Nitro-glycerin Compounds.—M. Dean.—The specification of the English patent No. 2226, A.D. 1881.

Industrial Society of Mulhouse.—Session of the Chemical Committee, April 13, 1882.—M. Albert Scheurer described to the Committee a new process for the fixation of certain colouring matters by the reduction of potassium chromate among the colour. The chromic oxide thus formed serves as a mordant upon which the colouring matter is fixed. The reduction of the chromate is effected by means of sodium sulphite or hyposulphite.

Journal für Praktische Chemie.
New Series. Vol. xxv., Part 7, 1882.

On the Compounds of the Mono and Bibasic Fatty Acids with Phenols.—M. Mencki.—In this fourth communication the author gives an account of cresol-aurine and orcin-aurine.

On the Admissibility of Plastered Wines.—M. Mencki.—The author thinks that the injurious nature of plastered wines containing more than 2 grms. per litre has not hitherto been proved by indubitable facts. It is, however, certain that "inconveniences" have been observed after the use of strongly plastered wines, and that the continued use of such wines may be injurious to health.

A Contribution to the Theory of Antisepsis.—Fr. Boillat.—The author replies to the conclusions of Dr. Koch that, of all the substances in repute as antiseptics, merely chlorine, bromine, iodine, mercuric chloride, and possibly potassium permanganate and osmic acid, deserve the name of disinfectants. He shows that agents which destroy the animal organism are applicable merely in the disinfection of lifeless objects. Albumen precipitated with phenol and washed certainly enters into putrefaction after 48 hours, but the author shows that the phenol is completely removed by washing. Metallic salts such as zinc chloride if applied to wounds produce instantly metallic albuminates, which, though they are not poisons for the Schizomycetes, afford them no suitable nourishment.

Chemical Analysis of the Oberbrunnen at Salzbrunn in Silesia.—R. Fresenius.—This paper is rather of medical than of chemical interest.

Verhandlungen des Vereins zur Beförderung des Gewerbfleisses. May, 1882.

This issue contains no chemical matter.

June, 1882.

Roasting Zinc Blende and Neutralising the Gases by means of Solution of Calcium Sulphide.—Dr. Kosmann.—The author first refers to Schnabel's process, in which the sulphuric and sulphurous acids of the gases from roasting metallic sulphides are absorbed by means of basic zinc carbonate, or by a mixture of zinc oxide with basic zinc sulphate. The process is technically successful, but the quantity of the absorbent material required is a fatal obstacle from a commercial point of view. For every per cent of sulphur in the blende which is roasted, two-and-a-half times the weight of zinc oxide must be used. Hence for a blende containing 40 per cent and 20 of sulphur, every kilo. requires 0·5 kilo. of zinc oxide. The removal and renewal or calcination of such quantities of the absorbent consumes too much labour and capital. The calcium sulphide process is described at length. The absorbent liquid is an aqueous solution of calcium mono-sulphide. It is found, however, that the product obtained by igniting a mixture of gypsum and coal contains not merely the mono-sulphide, but if it has been exposed to the air, polysulphides along with calcium hydrate. It has since been found preferable to prepare the solution by boiling sulphur with milk of lime. Here also poly-sulphides are present, but in a dilute lye, and in presence of calcium hydrate they pass into calcium sulph-hydrate. Along with the poly-sulphides calcium hyposulphite enters into solution, which also serves for the neutralisation of the sulphurous gases. The products of the absorption are free sulphur and gypsum. From 50 to 58 per cent of the sulphurous acid of the gases are absorbed.

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2. DEPARTMENT OF SCIENCE AND ENGINEERING.

The SESSION will commence in these Departments on TUESDAY, October 3. Students will be admitted on and after WEDNESDAY, September 27. Candidates for admission must not be under Fourteen Years of Age, and those under Sixteen will be required to pass an Entrance Examination in English, Arithmetic, and Elementary Latin, to be held on SEPTEMBER 29.

3. DEPARTMENT OF MEDICINE AND SURGERY.

The SESSION will commence on MONDAY, October 2. Students are required before entering to have passed one of the Preliminary Examinations prescribed by the General Medical Council.

4. EVENING CLASSES.

The SESSION will commence on MONDAY, October 9. New Students will be admitted on WEDNESDAY, THURSDAY, and FRIDAY preceding, between half-past 6 o'clock and 9 o'clock P.M.

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THE CHEMICAL NEWS.

Vol. XLVI. No. 1185.

ELECTRIC LIGHTING BY INCANDESCENCE.*

By JOSEPH W. SWAN.

(Concluded from p. 51.)

It is evident by the appearance of the flowers on the table that colours are seen very truly by this light, and this is suggestive of its suitability for the lighting of pictures.

The heat produced is comparatively very small, and of course there are no noxious vapours.

And now I may, I think, fairly say that the difficulties encountered in the construction of incandescent electric lamps have been completely conquered, and that their use is *economically practicable*. In making this statement I mean that, both as regards the *cost of the lamp* itself and the *cost of supplying electricity to illuminate it*, light can be produced at a cost which will compare not unfavourably with the cost of gas-light. It is evident that, if this opinion can be sustained, lighting by electricity at once assumes a position of the widest public interest, and of the greatest economic importance; and in view of this I may be permitted to enter with some detail into a consideration of the facts which support it.

There has now been sufficient experience in the manufacture of lamps to leave no doubt that they can be cheaply constructed, and we know by actual experiment that continuous heating to a fairly high degree of incandescence during 1200 hours does not destroy a well-made lamp. What the utmost limit of a lamp's life may be we really do not know. Probably it will be an ever-increasing span; as, with increasing experience, processes of manufacture are sure to become more and more perfect. Taking it, therefore, as fully established that *a cheap and durable lamp can now be made*, the further question is as to *the cost of the means of its illumination*.

This question in its simplest form is that of the more or less economical use of coal; for coal is the principal raw material alike in the production of gas and of electric light. In the one case the coal is consumed in producing gas which is burnt; in the other in producing motive power, and, by its means, electricity.

The cost of producing light by means of electric incandescence may be compared with the cost of producing gas light in this way:—2 cwts. of coal produce 1000 cubic feet of gas, and this quantity of gas, of the quality called 15-candle gas, will produce 3000 candle-light for one hour. But besides the product of gas, the coal yields certain by-products of almost equal value. I will therefore take it that we have, in effect, 1000 feet of gas from 1 cwt. of coal instead of from 2 cwts., as is actually the case.

And now, as regards the production of electricity. One cwt. of coal—that is, the same measure *in point of value* as gives 1000 feet of gas—will give 50 horse-power for one hour. Repeated and reliable experiments show that we can obtain through the medium of incandescent lamps at least 200 candle-light per horse-power per hour. But as there is waste in the conversion of motive power into electricity, and also in the conducting wires, let us make a liberal deduction of 25 per cent, and take only 150 candle-light as the nett available product of 1 horse-power; then for 50 horse-power (the product of 1 cwt. of coal) we have 7500 candle-light, as against 3000 candle-light from *an equivalent value* of gas—that is to say, two and a half times more light.

There still remains an allowance to be made to cover the cost of the renewal of lamps. There is a parallel expense in connection with gas lighting in the cost of the renewal of gas-burners, gas globes, gas chimneys, &c. I cannot say that I think these charges against gas lighting will equal the corresponding charges against electric lighting, unless we import into the account—as I think it right to do—the consideration that, without a good deal of expense be incurred in the renewal of burners, and unless minute attention be given, far beyond what is actually given, to all the conditions under which the gas is burned, nothing like the full light product which I have allowed to be obtainable from the burning of 1000 cubic feet of gas will be obtained, and, as a matter of fact, is not commonly obtained, especially in domestic lighting. Taking this into account, and considering what would have to be done to obtain the full yield of light from gas, and that if it be not done, then the estimate I have made is too favourable, I think but little, if any, greater allowance need be made for the charge in connection with the renewal of lamps in electric lighting than ought to be made for the corresponding charges for the renewal of gas-burners, globes, chimneys, &c. But it will be seen that, even if the cost for renewal of lamps should prove to be considerably greater than the corresponding expense in the case of gas, there is a wide margin to meet them before we have reached the limit of the cost of gas lighting.

I think, too, it must be fairly taken into account, and placed to the credit of electric lighting, that by this mode of lighting there is entire avoidance of the damage to furnishings and decorations of houses, to books, pictures, and to goods in shops, which is caused through lighting by gas, and which entails a large expenditure for repair, and a large amount of loss which is irreparable.

I have based these computations of cost of electric light on the supposition that the light product of 1 horse-power is 150 candles. But if durability of the lamps had not to be considered, and it were an abstract question how much light can be obtained through the medium of an incandescent filament of carbon, then one might, without deviating from ascertained fact, have spoken of a very much larger amount of light as obtainable by this expenditure of motive power. I might have assumed double, or even more than double, the light for this expenditure. Certainly double and treble the result I have supposed can actually be obtained. The figures I have taken are those which consist with long life to the lamps. If we take more light for a given expenditure of power, we shall have to renew the lamps oftener, and so what we gain in one way we lose in another. But it is extremely probable that a higher degree of incandescence than that on which I have based my calculations of cost may prove to be compatible with durability of the lamps. In that case the economy of electric lighting will be greater than I have stated.

In comparing the cost of producing light by gas and by electricity, I have only dealt with the radical item of coal in both cases. Gas lighting is entirely dependent upon coal,—electric lighting is not,—but in all probability coal will be the chief source of energy in the case of electric lighting also. When, however, water power is available, electric lighting is in a position of still greater advantage, and, in point of cost, altogether beyond comparison with other means of producing light.

To complete the comparison between the cost of electric light and gas light, we must consider not only the amount of coal required to yield a certain product of light in the one case and in the other, but also the cost of converting the coal into electric current and into gas; that is to say, *the cost of manufacture* of electricity and *the cost of manufacture* of gas. I cannot speak with the same exactness of detail on this point as I did on the comparative cost of the raw material. But if you consider the nature of the process of gas manufacture, and that it is a process, in so far as the lifting of coal by manual labour is concerned, not very unlike the stoking of a steam boiler, and if electricity is generated by means of steam, then the

* A Lecture delivered at the Royal Institution, March 10, 1882.

manual labour chiefly involved in both processes is not unlike. It is evident that in gas manufacture it would be necessary to shovel into the furnaces and retorts five or six times as much coal to yield the same light product as would be obtainable through the steam-engine and incandescent lamps. But here again it is necessary to allow for the value of the labour in connection with the products other than gas, and hence it is right to cut down the difference I have mentioned to half,—*i.e.*, debit gas with only half the cost of manufacture, in the same way as in our calculation we have charged gas with only one-half the coal actually used. But when that is done there is still a difference of probably three to one in respect of labour in favour of electric lighting.

I have made these large allowances of material and labour in favour of the cost of gas, but it is well known that the by-products are but rarely of the value I have assumed. I desire, however, to allow all that can be claimed for gas.

With regard to the *cost of plant* I think there will be a more even balance in the two cases. In a gas-works you have retorts and furnaces, purifying chambers and gasometers, engines, boilers, and appliances for distributing the gas and regulating its pressure. Plant for generating electricity on a large scale would consist principally of boilers, steam-engines, dynamo-electric machines, and batteries for storage.

No such electrical station, on the scale and in the complete form I am supposing, has yet been put into actual operation; but several small stations for the manufacture of electricity already exist in England, and a large station designed by Mr. Edison is, if I am rightly informed, almost completed in America. We are therefore on the point of ascertaining, by actual experience, what the *cost of the works* for generating electricity will be. Meanwhile we know precisely the cost of boilers and engines, and we know approximately what ought to be the cost of dynamo-electric machines of suitably large size. We have therefore sufficient grounds for concluding that, to produce a given quantity of light electrically, the cost of plant would not exceed greatly, if at all, the cost of equivalent gas plant.

There remains to be considered, in connection with this part of the subject, the *cost of distribution*. Can electricity be distributed as widely and cheaply as gas? On one condition, which I fully hope can be complied with, this may be answered in the affirmative. The condition is that it be found practicable and safe to distribute electricity of comparatively high tension.

The importance of this condition will be understood when it is remembered that, to effectively utilise electricity in the production of light in the manner I have been explaining, it is necessary that the *resistance in the carbon of the lamps* should be relatively great to the *resistance in the wires which convey the current to them*. When lamps are so united with the conducting wire that the current which it conveys is divided amongst them, you have a condition of things in which the aggregate resistance of the lamps will be very small, and the conducting wire, to have a relatively small resistance, must either be *very short*, or, if it be long, it must be *very thick*, otherwise there will be excessive waste of energy; in fact, it will not be a practical condition of things.

In order to supply the current to the lamps economically there should be comparatively little resistance in the line. A waste of energy, through the resistance of the wire, of 10 or perhaps 20 per cent might be allowable, but if the current is supplied to the lamps in the manner I have described,—that of *multiple arc*, each lamp being as it were *a crossing between two main wires*,—then, and even if the individual lamps offered a somewhat higher degree of resistance than the lamps now in actual use, the thickness of the conductor would become excessive if the line was far extended. In a line of half a mile, for instance, the weight of copper in the conductor would become so great, in proportion to the number of lamps supplied through it, as to be a serious charge on the light. On the other hand, if a smaller conducting wire were used, the waste of energy and consequent cost would greatly exceed that I have mentioned as the permissive limit.

Distribution in this manner has the merit of simplicity; it involves no danger to life from accidental shock, and it does not demand great care in the insulation of the conductor. But it has the great defect of limiting within comparatively small bounds the area over which the power for lighting could be distributed from one centre. In order to light a large town electrically on this system it would be necessary to have a number of supply stations, perhaps half a mile or a mile apart. It is evidently desirable to be able to effect a wider distribution than this, and I hope that either by arranging the lamps *in series*, so that the same current passes through several lamps in succession, or by means of *secondary voltaic cells*, placed as electric reservoirs in each house, it may be possible to economically obtain a much wider distribution.

Whether by the method of multiple arc, which necessitates the multiplication of electrical stations, or by means of the simple series, or by means of secondary batteries connected with each other from house to house in single series, the lamps being fed from these in multiple arc, I am quite satisfied that, comparatively with the distribution of gas, the distribution of electricity is sufficiently economical to permit of its practical application on a large scale.

As to the cost of laying wires in a house, I have it on the authority of Sir Wm. Thomson, who has just had his house completely fitted with incandescent lamps from attics to cellars,—to the entire banishment of gas,—that the cost of internal wires for the electric lamps is less than the cost of plumbing in connection with gas-pipes.

I have expended an amount of time on the question of *cost* which I fear must have been tedious; but I have done so from the conviction that the practical interest of the matter depends on this point. If electric lighting by incandescence is not an economical process, it is unimportant; but if it can be established—and I have no doubt that it can—that this mode of producing light is economical, the subject assumes an aspect of the greatest importance.

Although at the present moment there may be deficiencies in the apparatus for generating and storing electricity on a very large scale, and but little experience in distributing it for lighting purposes over wide areas, and consequently much yet to be learnt in these respects, yet, if once it can be clearly established that, light for light, electricity is as cheap as gas, and that it can be made applicable to all the purposes for which artificial light is required, electric light possesses such marked advantages in connection with health, with the preservation of property, and in respect of safety, as to leave it as nearly certain as anything in this world can be, that the wide substitution of the one form of light for the other is only a question of time.

Treatment of an Ore of Selenium (Zorgite) from the La Plata.—M. Billaudot.—This ore is essentially a lead selenide, containing 30 per cent of selenium. It is finely powdered and treated with an *aqua regia*, composed of 5 parts of hydrochloric acid to 1 part nitric acid. The solution is concentrated at a gentle heat to expel the nitric and hydrochloric acids, the paste-like mass is taken up in water, which dissolves merely the copper chloride and the selenious acid, leaving lead chloride insoluble. This latter is washed methodically; the washings are added to the solution and the whole treated with a current of sulphurous acid, which throws down all the selenium as a red maroon deposit. This deposit is washed in water to remove copper chloride, boiled in a large platinum dish with pure hydrochloric acid to remove the last traces of lead chloride, washed with pure water, and melted in a graphite crucible. The price of selenium has fallen from 1000 to 40 frs. per kilo.—*Journ. de Pharm.*

ON CERTAIN SUBSTANCES OBTAINED FROM TURMERIC.

I.—CURCUMIN.*

By C. LORING JACKSON and A. E. MENKE.

THE chemical study of curcumin, the yellow colouring-matter of turmeric, dates from a paper† by A. Vogel, Sr., and Pelletier, published in 1815, although even before this turmeric paper had been used as a test for alkalies, and its action with boric acid and various salts observed.‡ No analysis is given in this paper, and the low melting-point (40°) and description of the method of preparation show that the "yellow colouring-matter of turmeric" obtained by Vogel and Pelletier was principally composed of resin and turmeric oil; they proved, however, that it contained no nitrogen, and studied its action with alkalies, acids, and certain salts, especially acetate of lead.

In 1842, A. Vogel, Jr.,§ analysed a similar but perhaps somewhat purer preparation, which, however, must have consisted in great part of the yellow resin contained in the root, as it also melted at 40°; it is not wonderful, therefore, that his analyses led to no formula.

Passing over a number of unimportant notices,‖ we come next to a paper by Schlumberger,¶ in which the action of a mixture of sulphuric and boric acids on crude curcumin is studied, and a description given of the product called by him roso-cyanin, because it dissolved in alcohol with a fine red colour, and was turned blue by alkalies. He also describes a resinous product of the action of boric acid on curcumin (pseudo-curcumin).

Two years later, in 1868, Bolley, Suida, and Lange** examined the turmeric oil, and published a new analysis of a purer curcumin (melting-point 120°); but it was not till 1870 that curcumin was obtained essentially pure. In this year Daube,†† Ivanow-Gajewsky,‡‡ and Kachler§§ published independent papers on the subject, of which Ivanow-Gajewsky's is entitled to the precedence, as the number of the *Berlin Berichte* which contained Daube's original paper gave a notice in the Correspondence of the reading of Gajewsky's paper before the Russian Chemical Society a month earlier. In addition to an analysis of the turmeric oil, he assigns, as the simplest possible, the formula C_4H_4O to curcumin, which after crystallisation from ether or benzin melted at 172°. Daube, on the other hand, after extracting his curcumin with benzol, and purifying it by conversion into the lead salt, obtained the melting-point 165°, and the formula $C_{10}H_{10}O_3$. He also found that it was decolourised by sodium amalgam and alcohol, and converted into oxalic acid by dilute nitric acid.

Kachler, who did not succeed in crystallising his curcumin, although both Ivanow-Gajewsky and Daube got crystals, obtained the same formula as the former, that is, C_4H_4O, or some multiple of it. He also studied the action of sodium amalgam upon it, and that of hot zinc-dust, but with no very definite results in either case; whereas by fusing curcumin with potassic hydrate, he obtained proto-catechuic acid. From the turmeric oil he obtained essentially the same analytical results as Ivanow-Gajewsky.

In 1872 Ivanow-Gajewsky published a second paper* on turmeric, containing another method for extracting curcumin, which, however, gave it a melting-point of 140°, and an analysis of the lead salt supporting his formula $C_{16}H_{16}O_4 (= (C_4H_4O)_4)$. Moreover, he confirmed the results of Kachler with fusing potassic hydrate (proto-catechuic acid) and zinc-dust, and states that the oil obtained with the latter is identical with turmeric oil, of which a new analysis is given, and its oxidation (yielding valeric and caproic acids) and action with phosphoric penta-chloride studied. He also prepared and analysed roso-cyanin, but was unable to find a satisfactory formula for it.

Finally, in 1873, he published the last paper† we have been able to find on this subject, in which he states that curcumin yields, on oxidation with potassic dichromate, terephthalic acid, and that roso-cyanin contains no boron, and, fused with potassic hydrate, yields para-oxy-benzoic acid.

In brief, the following facts had been established in regard to curcumin at the time that we began our research upon it:—Its formula was either $C_{10}H_{10}O_3$ or $C_{16}H_{16}O_4$; the highest melting-point observed was 172°; with alkalies it formed reddish brown salts; with boric and sulphuric acids, roso-cyanin; it was susceptible of reduction, and gave an oil with zinc-dust; by oxidation it yielded oxalic acid or terephthalic acid, and by fusion with caustic potash proto-catechuic acid.

Accordingly we first turned our attention to the determination of its formula.

Extraction and Purification of Curcumin.

After several experiments we have adopted the following method as the best and most convenient:—The turmeric oil is first removed from the ground root by treatment with ligroine;‡ then the curcumin, mixed with a large quantity of resin, is extracted with ether, and finally purified by crystallisation from alcohol.

The turmeric used by us has been principally Bengal turmeric, bought of Messrs. E. and F. King, of Boston; we have, however, also extracted enough of the Madras turmeric, the only other brand occurring in the Boston market, to assure ourselves of the identity of the curcumin obtained from both.

For a full description and history of turmeric, which consists of the root-stocks of the *Curcuma longa*, a plant of the ginger family, growing in India and other parts of the East, we would refer to Flückiger and Hanbury's "Pharmacographia,"§ and to a full botanical article recently published by A. Meyer‖ in the *Archives de Pharmacie*.

The extracter was of the form recently described by Scheibler,¶ as this was the only one of which we have found a description adapted to the thorough extraction of large quantities of material; those forms in which the drug is not kept covered with the extracting liquid being apt to leave the edges partially unacted on. The only modification of Scheibler's apparatus made by us consisted in substituting a cylindrical tin vessel capable o holding 10 kilos. of ground turmeric for the smaller glass vessel used by him. With a cooler 78 c.m. long, the inner tube of which was a flattened U, also made of tin, the thorough extraction of the 10 kilos. of turmeric could be accomplished in little more than a fortnight. The solven was removed, after it had ceased to act, by forcing out a much as possible of it by air pressure, and then distilling off the rest by filling with steam a jacket which surrounded the vessel containing the turmeric.

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* From the *Proceedings of the American Academy*. Communicated by the Authors.

† *Journal de Pharmacie*, 1, 289.

‡ Trommsdorff, *Trommsdorff's Journal von Pharm.*, 16, 96. Sementini, *Bibliothèque Britannique*, Jan., 1815.

§ *Journal de Pharm. et de Chemie*, sér. 3, 2, 20.

‖ Desfosses, *Ann. Chim. Phys.*, 16, 76; A. Vogel, Jr., *Répert. Pharm.*, sér. 3, 3, 178; H. Rose, *Pogg. Ann.*, 102, 545; Lepage, *Archiv. der Pharm*, ser. 2, 97, 240; Leube, *Vierteljahrsschr. Pract Pharm.*, 9, 395; Alex. Müller, *Journ. Prakt. Chem.*, 80, 119; Wittstein, *Vierteljahrsschr. Prak. Pharm.*, 9, 282; Schutzenberger, *Paraf. Mul. Soc. Bull.*, 1861, 503; Ludwig, *Archiv. der Pharm.*, 106, 169; Kraut, *Zeitschr. Anal. Chem.*, 4, 168.

¶ *Bull. Soc. Chim.*, ser. 2, 5, 194.

** *Journ. Prak. Chem.*, 103, 474.

†† *Ber. Deut. Chem. Ges.*, 3, 609.

‡‡ *Ibid.*, 3, 624.

§§ *Ibid.*, 3, 713.

* *Ber. Deut. Chem. Ges.*, 5, 1103.

† *Ibid.*, 6, 196.

‡ In our first experiments we followed Ivanow-Gajewsky, and used carbonic disulphide for this purpose; but we have found that ligroine is not only much cheaper and more agreeable to work with, but yields a purer oil.

§ Macmillan and Co., London 1879.

‖ *Archiv. Pharm.*, ser. 3, 18, 401.

¶ *Ber. Deut. Chem. Ges*, 13, 338.

The ligroine extract yielded on evaporation a dark yellow oil, amounting on the average to 11 per cent of the weight of the root. The investigation of this substance will be described in a later paper.

The ether extract, a reddish brown mass, varying in consistency from semi-liquid to solid according to the period of the extraction at which it was obtained, was treated with successive small quantities of cold alcohol, which dissolved the viscous impurities more easily than the curcumin. In very obstinate cases washing with ether was found advantageous; if, on the other hand, the extract was comparatively free from resin, it could be washed with alcohol upon a filter. In either case the residue was purified by re-crystallisation from alcohol until it showed the constant melting-point 178°.

The average yield of curcumin was 0·3 of 1 per cent; this, however, is only the amount that can be extracted by the process just described; the quantity contained in the root is much larger, as a considerable amount remained mixed with the resinous impurities, and the green fluorescence of the crude turmeric oil pointed to the presence of some curcumin in this substance.

Composition of Curcumin.

The following combustions were made of the curcumin purified as just described and dried at 100°. In most of these analyses a slight ash was left, the amount of which has been subtracted from the weight of substance before calculating the percentages.

I. 0·1106 grm. of substance gave 0·2774 grm. of CO_2 and 0·0563 grm. of H_2O. No ash.

II. 0·2180 grm. gave 0·5450 grm. of CO_2 and 0·1099 grm. of H_2O. Ash 0·0007 grm.

III. 0·2149 grm. gave 0·5376 grm. of CO_2 and 0·1090 grm. of H_2O. Ash 0·0006 grm.

IV. 0·2195 grm. gave 0·5480 grm. of CO_2 and 0·1099 grm. of H_2O. Ash 0·0006 grm.

V. 0·2743 grm. gave 0·6815 grm. of CO_2 and 0·1378 grm. of H_2O. Ash 0·0010 grm.

	I.	II.	III.	IV.	V.	Mean.
Carbon ..	68·43	68·39*	68·42*	68·27*	68·00	0·30
Hydrogen	5·65	5·62	5·69	5·59	5·60	5·63

All these analyses were made with curcumin from Bengal turmeric: I. and II. of different portions of the same sample, III., IV., and V. of different samples.

The following analysis was made of curcumin extracted from Madras turmeric:

0·3467 grm. gave 0·8612 grm. of CO_2 and 0·1870 grm. of H_2O. No ash.

Carbon	67·74
Hydrogen	5·99

The sample analysed was very red, and the somewhat lower percentage of carbon obtained was undoubtedly due to the presence of an impurity which causes the curcumin to crystallise in red burrs, as is shown by the following analysis of a very red sample of Bengal curcumin:

0·2168 grm. of substance gave 0·5400 grm. of CO_2 and 0·1057 grm. of H_2O. No ash.

Carbon	67·93
Hydrogen	5·42

It is to be observed, however, that enough of this impurity to change the crystalline habit and colour of the curcumin has but a very slight effect on the percentage composition, and, it may be added, does not lower the melting-point more than one degree. That it is formed by the oxidation of curcumin by the action of the air, appears from the fact that pure yellow curcumin was partially converted into red burrs when moistened with alcohol and exposed to the air for a long time. When once formed, the impurity can be removed only by repeated crystallisation, and the amount of Madras curcumin at our disposal did not admit of this, nor did we take the trouble to prepare a larger supply, as the above analysis with the melting-point 178° is sufficient to establish the identity of the Madras and Bengal curcumins.

The following comparison shows that our results agree tolerably well with those of Daube, but are entirely at variance with those of Kachler and Ivanow-Gajewsky. (As no analyses are given in the abstract of the latter's article, which alone is at our disposal, we have given the theory for his formula, $C_{16}H_{16}O_4$, under his name.)

	Ivanow-Gajewsky.	Kachler.		Daube.		Jackson and Menke. Mean.
Carbon ..	70·58	69·90	69·87	67·90	67·89	67·92	68·30
Hydrogen	5·90	5·70	5·59	5·66	5·76	5·70	5·63

There are, then, eight analyses of curcumin which support a percentage of carbon in the neighbourhood of 68, against three (or more) in favour of one near 70.*

It is probable that the high results obtained by Ivanow-Gajewsky and Kachler were due to the presence of resinous impurities, since their predecessors, who analysed exceedingly impure curcumin, as shown by the low melting-point, obtained the following results:

	A. Vogel, Jr.	Bolley, Suida, and Lange.
Carbon	69·50	69·07
Hydrogen	7·46	6·40

This view is further supported by the fact that we obtained a higher melting-point, 178°, than any one else; Daube found 165°, Ivanow-Gajewsky 172°, later 140°, while Kachler gives no melting-point, and did not succeed in obtaining his curcumin crystallised. In view of these facts we feel no hesitation in rejecting all the previous analytical results except those of Daube.

Daube gives curcumin the formula $C_{10}H_{10}O_3$, but our results, and for that matter his, agree much better with the formula $C_{14}H_{14}O_4$, as appears from the following comparison:

	$C_{10}H_{10}O_3$.	$C_{14}H_{14}O_4$.	Daube.	Jackson and Menke.
Carbon ..	67·42	68·29	67·90	68·30
Hydrogen ..	5·62	5·69	5·70	5·63

We have therefore adopted the formula $C_{14}H_{14}O_4$, which is also confirmed by the analyses of derivatives of curcumin to be given later in the paper.

(To be continued.)

ACTION OF ALUMINIUM UPON CUPRIC CHLORIDE.

By Dr. D. TOMMASI.

ALUMINIUM reacts briskly upon cupric chloride, even at the ordinary temperature, the products being hydrogen, metallic copper, and an aluminium oxychloride, the composition of which varies according to the degree of concentration of the copper solution. If again aluminium is caused to react in heat upon a solution of these oxychlorides there is obtained as final product a compound of the formula $Al_2Cl_6(Al_2O_33H_2O)_{6,12}H_2O$.

The following is the process which the author has followed for the preparation of this oxychloride:—He adds an excess of aluminium to a solution containing 31·25 per cent of $CuCl_2$; when the copper is precipitated he filters, and adds to the filtrate a few fragments of aluminium,

* These numbers become, if the ash is not subtracted from the weight of the substance:

	II.	III.	IV.	V.
Carbon	68·17	68·23	68·09	67·75
Hydrogen	5·00	5·64	5·56	5·58

* Ivanow-Gajewsky obtained a percentage of lead in a plumbic salt agreeing with his combustion; but this result is more than counterbalanced by the analyses of derivatives of curcumin given later in this paper.

and heats on the sand-bath. This reaction is effected in a flat-bottomed flask with a long neck, fitted with a small funnel. When the liquid is heated the aluminium begins to dissolve with an escape of hydrogen. Towards 70° the reaction is brisk, and becomes violent at 100°. When all the aluminium is dissolved a fresh quantity is added, until it ceases to dissolve even at a boiling-heat.

A little water must be added from time to time to preserve the liquid at the same volume. When the reaction is at an end the liquid is filtered. This solution of oxychloride does not crystallise, and to obtain it in a solid state it is first evaporated to a syrup in the water-bath, then spread out upon a plate of glass, which is heated in the stove to between 40° and 50°. The oxychloride thus obtained is in the form of white scales resembling potassium borico-tartrate. When dried at 100° this compound contains 14·93 per cent chlorine and 27·69 per cent aluminium. The solution of this oxychloride, like ferric oxychloride, possesses the singular property of being precipitated by the addition of sulphuric acid or of certain salts. A single drop of concentrated sulphuric acid occasions a precipitate of hydrated alumina so copious that the whole liquid gelatinises. The hydrated alumina thus obtained is sparingly soluble in sulphuric acid, which makes the author suppose that it is not ordinary alumina, but an isomeric modification of the trihydrate.—*Les Mondes.*

THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.*

By Prof. J. W. MALLET, F.R.S., University of Virginia.

This research was undertaken in compliance with the instructions of a letter from the President of the National Board of Health, written on behalf of the Executive Committee of the Board, and dated Washington, December 29, 1880.

A full report on the objects, in detail, of the investigation, on the methods employed, and the results obtained. has been prepared and placed in the hands of the Board. Pending its publication *in extenso*, the Executive Committee has thought proper to direct that an abstract, covering the principal conclusions reached, shall be published. The following presents such an abstract:—

It was intended to examine carefully the chief processes in use for chemically determining the organic matter. or its constituents, in drinking-water, to test the absolute and relative accuracy of the results these processes are capable of yielding, and as far as possible to ascertain the nature and scope of the practical conclusions available for sanitary purposes which may thence be secured.

Three chemists took charge severally of the so-called "combustion process" of Frankland and Armstrong, the "albumenoid-ammonia process" of Wanklyn, Chapman, and Smith, and the "permanganate process" originally suggested by Forchhammer, in the form advocated and minutely described by Tidy. These gentlemen, Mr. W. A. Noyes, Dr. Charles Smart, U.S.A., and Dr. J. A. Tanner, U.S.N., worked independently, the first in the laboratory of the Johns Hopkins University at Baltimore, by permission of its authorities; the second at the office of the National Board of Health, in Washington; and the third in the laboratory of the University of Virginia. Arrangements were made to have the samples of water for examination collected, and distributed to these three points by myself, so that there should be identity of material submitted to each analyst, and all three analysts should examine their several samples on the same day. Prof. H. Newell Martin, of the Johns Hopkins University, kindly undertook a simultaneous microscopic examination of the waters placed in the hands of the chemists, as also a series of pathological observations on the effect of injecting the waters, concentrated by evaporation at very low temperature, beneath the skin of rabbits, whose temperature and general condition were compared with those of like animals not so treated.

A large amount of preliminary and special work was done in the early part of 1881, the former chiefly with a view to making the analysts thoroughly familiar with the processes to be tested before coming to the actual tests themselves, the latter on various modifications of the processes in detail, and incidental points in connection with them of sanitary interest. From this work a number of results of considerable interest have been obtained, but their publication will have to be made in their place in the general report.

For the main series of test analyses the following classes of waters were obtained or prepared:—

Class I.—Natural waters, believed from actual use to be of good wholesome character, including the regular water supply of some of the principal cities of the United States.

Class II.—Natural waters which there seems to be fair ground for believing have actually caused disease on the part of those drinking them. A request for information as to such waters, and for samples of them, was published for several months in the *National Board of Health Bulletin*, and was extensively copied into newspapers and professional journals, and a copious correspondence with physicians and others in various parts of the country was employed to secure such samples, and to sift the evidence as to the supposed connection of the use of each water with the production of disease.

Class III.—Natural waters, of doubtful, but more or less suspected, character. In reference to these the medical evidence was insufficient to justify placing them in Class II.

Class IV.—Artificially prepared waters, made by adding to good wholesome water determinate amounts of various infusions of *vegetable* organic matter, of natural origin, and of such kinds chiefly as water for human consumption is liable to be brought in contact with.

Class V.—Artificially prepared waters, made as above, with various forms of *vegetable* refuse from manufacturing or industrial operations.

Class VI.—Artificially prepared waters, as above, made with *animal* (or partly animal) organic matter of natural origin, especially such as are likely to occur in connection with the contamination of drinking-water.

Class VII.—Artificially prepared waters, as above, made with *animal* refuse from manufacturing or industrial operations.

Class VIII.—Artificially prepared waters, as above, to which had been added morbid products from certain diseases in the human subject.

Class IX.—Solutions, in distilled water, of carefully determined amounts of pure substances of definite chemical composition.

The results obtained from the examination of a large number of samples, representing the above classes of waters, are given in detail in a table in the general report. At present the conclusions reached in the discussion of these results can alone be given.

General discussion of Results.

Degree of Accuracy of the three Principal Processes Examined.—This may be looked at in two ways:—First, as to the concordance of the results obtained by each process in duplicate or triplicate experiments on the same water; and, secondly, as to the agreement of the results obtained with the actual contents of a particular water when these are quantitatively known.

In the former of these aspects we have to do with such errors as are, practically speaking, fortuitous; in the

* Preliminary Report on the results of an investigation, made by direction of the National Board of Health, as to the chemical methods in use.

latter we notice especially the indications of constant errors inherent in the methods used.

Extent of Concordance of the Results obtained by each Process in Multiplied Experiments on the same Water.—This has been tested by taking the mean of duplicate or triplicate determinations, noting the difference between this mean and each of the individual determinations on which it was based, and calculating this difference as percentage on the mean itself. The data for such calculation have been most numerous in the case of the combustion process, since it was considered necessary to make duplicate analyses all through the research, with a number of triplicates. It is the more important that this process should be thus examined, in view of the objection which has been often made to it, that it demands an unusual degree of skill and training on the part of the experimenters. In connection with the extensive work of the English Commission on the Pollution of Rivers, it is to be supposed that many duplicate analyses must have been made by this method, but there has appeared but little in print to show how far these were concordant. The results obtained in the course of the present research are summarised in Tables XI., XII., and XIII.

TABLE XI.—Extent of disagreement of results of multiplied analyses of same water by combustion process.

	Divergence of Individual Results from Mean, *as per-centage on mean*.		
	Greatest.	Least.	Avrge.
For all waters in Classes I. to VIII. inclusive, save the few for which there was but one analysis and those for which there was a known source of error vitiating one of the analyses.*			
Organic carbon..	24·46†	0	4·24
Ditto, rejecting twelve cases in which the divergence was over 10 per cent (ten of these cases involved very minute absolute quantities of carbon)	9·96	0	2·89
Organic nitrogen	40·00‡	0	9·48
Ditto, rejecting thirteen cases in which the divergence was over 20 per cent (ten of these cases involved very minute absolute quantities of nitrogen)	19·82	0	7·09
For the waters in Class IX. (solutions of definite chemical substances in known amount.§			
Organic carbon..	50·00‖	0·15	9·54
Ditto, rejecting six cases in which the divergence was over 10 per cent (four of these cases involved very minute absolute quantities of carbon)	7·76	0·15	2·81
Organic nitrogen	14·52¶	0	5·05
Ditto, rejecting five cases in which the divergence was over 10 per cent (but one of these cases involved a very minute quantity of nitrogen)	9·75	0	2·71
Average of both the above sets of experiments, giving them equal weight.			
Organic carbon (including all cases)	37·23	0·07	6·89
Ditto (rejecting in all thirty-six extreme cases, as above) ..	8·86	0·07	2·85
Organic nitrogen (including all cases)	27·26	0	7·26
Ditto (rejecting in all thirty-six extreme cases, as above) ..	14·78	0	4·90

* Representing in all two hundred and sixty-two separate analyses for carbon and two-hundred and forty-six for nitrogen. (Some analyses for the latter element were vitiated by uncertainty in the determination of free ammonia, and hence in the amount to be subtracted for this latter.)

† Actual difference was less than 0·3 milligrm.

‡ Actual difference was only 0·04 milligrm.

§ Representing in all forty-one separate analyses each for carbon and nitrogen. (One determination for each was without a duplicate, and hence had to be rejected from the data for this table.)

‖ Actual difference was 0·035 milligrm.

¶ Actual difference was 0·47 milligrm.

TABLE XII.—Extent of disagreement of results of multiplied experiments on same water by albumenoid-ammonia process.

	Divergence of Individual Results from Mean, *as per-centage on mean*.		
	Greatest.	Least.	Avrge.
For thirteen waters in Classes I. to VIII. examined in triplicate.*			
Free ammonia	36·05	0	5·91
Ditto, rejecting two cases involving very minute quantities of free NH_3	19·05	0	2·79
Albumenoid ammonia	8·51	0	2·69
For waters of Class IX. (twenty-one in all—all examined in duplicate).†			
Free ammonia	5·53	0	1·67
Albumenoid ammonia	14·28	0	6·19
Ditto, rejecting four cases involving very minute quantities of alb. NH_3	12·79	0	4·56
Average of both the above sets of experiments, giving them equal weight.			
Free ammonia (including all cases)	20·79	0	3·79
Ditto (rejecting two extreme cases, as above)	12·29	0	2·23
Albumenoid ammonia (including all cases)..	11·39	0	4·44
Ditto (rejecting four extreme cases, as above)	10·65	0	3·62

* Representing thirty-nine separate determinations.

† Representing forty-two separate determinations; of course purely negative results are not included in the data for this table.

TABLE XIII.—Extent of disagreement of results of multiplied experiments on same water by the permanganate process.

	Divergence of Individual Results from Mean, *as per-centage on mean*.		
	Greatest.	Least.	Avrge.
For twelve waters in Classes I. to VIII., examined in duplicate.*			
Oxygen consumed in 1 hour†..	4·70	0	1·09
Oxygen consumed in 3 hours‡	4·35	0	0·56
For waters of Class IX. (twenty-one in all, all examined in duplicate).§			
Oxygen consumed in 1 hour‖..	8·33	0	0·62
Oxygen consumed in 3 hours¶	6·66	0	1·10
Average of both the above sets of experiments, giving them equal weight.			
Oxygen consumed in 1 hour ..	6·51	0	0·85
Oxygen consumed in 3 hours..	5·50	0	0·83

* Representing twenty-four separate determinations.

† Including five cases in which divergence was over 1 per cent (in all these but very little oxygen was consumed).

‡ Including two cases in which divergence was over 1 per cent (in these very little oxygen was consumed).

§ Representing forty-two separate determinations. Of course those are not included in the data for this table which showed no oxygen, or but a mere trace, consumed.

‖ Including one case in which divergence was over 1 per cent (very little oxygen consumed).

¶ Including three cases in which divergence was over 1 per cent (very little oxygen consumed).

Of the figures given in the last column of Table XI. those which probably represent with most fairness the average departure from the mean of an individual determination by the combustion process* are—

	Per cent.
For organic carbon	2·89
For organic nitrogen	7·09

This goes in part to support the opinion of Tidy,† that the results of the combustion process are less to be relied on for nitrogen than for carbon.

The results shown for the waters of Class IX. are less deserving of attention in this particular respect, since there were but seven different organic substances included, and these specially selected. The reversal of position of the carbon and nitrogen results in this class, as compared with the preceding, is partly due to great and variable loss by evaporation of the volatile organic acids, and by dissociation of the salts of the amines, &c.

From the last column of Table XII. the figures which probably may most fairly be taken to represent the average divergence from the mean of a single determination by the albumenoid-ammonia process are—

	Per cent.
For free ammonia	2·23
For albumenoid ammonia	3·62

We should naturally expect to find greater irregularity in the evolution of the so-called albumenoid ammonia, though the conditions of chemical action be made as nearly as possible the same.

As regards the averages in the last column of Table XIII. the consumption of oxygen by the waters in Class IX. having been for the most part very small, it seems probable that, for practical purposes, the first figures may best be taken, viz.—

	Per cent.
For oxygen consumed in one hour	1·09
For oxygen consumed in three hours ..	0·56

showing somewhat greater irregularity in the early stage of the action than later.

It will be seen that on the whole the most closely concordant results were furnished by the permanganate process, and the least so by the combustion process, the albumenoid-ammonia process holding the intermediate position.

Extent of agreement of the results obtained by the different processes with the quantities of organic constituents known to be actually present.—The detailed evidence under this head is given in columns 19 to 25, inclusive, of the last sheet of Table X., in which the results actually obtained on examination of the waters in Class IX. (solutions of known amounts of certain organic substances of definite chemical composition) are compared with the amounts of the organic elements really present and the calculated amounts of oxygen required for their complete oxidation.‡ The following summary (in Table XIV.) presents the conclusions reached within the limits of these experiments.

The figures of this table strikingly indicate certain important defects of the several processes, although they must be looked at in a broad, general way, remembering the small number of organic substances treated, and their special characters.

As regards the combustion process we find loss of carbon in all cases considerable, and in some cases very great, with a strong tendency on the whole to excess of nitrogen,

Table XIV.—Extent of agreement of results obtained by the different processes with the known chemical character of the waters in Class IX.

	Amounts obtained, as percentage upon Amounts calculated.		
	Grtst.	Least.	Avrge.
Combustion process.			
Organic carbon	85·0	1·0	53·0
Organic nitrogen (including that of ammonia)	180·0	47·0	118·0
Albumenoid-ammonia process.			
Nitrogen of free NH_3*	94·0	0	(28·0)†
Nitrogen of alb. NH_3*	84·0	0	(24·0)†
	95·0	0	53·0
Permanganate process.			
Oxygen consumed in 1 hour	13·0	0	3·0
Oxygen consumed in 3 hours	16·0	0	4·0

(In this Table, as in the last sheet of Table X., a considerable fraction of 1 per cent is represented by 1— ; an insignificant fraction is considered =0.)

* Both calculated as percentage on *total* nitrogen present.

† These two averages have no real significance.

which in some cases is very great. It is of course easy to see how, in large measure at least, these errors were caused for some of the samples. Thus, doubtless, free butyric and valerianic acids were formed from their salts, and volatilised with the water during its evaporation; the salts of the amines probably suffered partial dissociation, with volatilisation of the bases, and urea was lost after conversion into ammonium carbonate. It may be objected that such substances as these ought not to have been selected. But it is to be remembered that every one of them occurs among the products of putrefactive decay of albumenoid or other organic matter, and hence may fairly be looked for among the constituents of organically polluted water.*

The occurrence of loss of organic constituents during the evaporation of water for the combustion process has often been suspected by the critics of that process,† and often, though sometimes cautiously, denied by its advocates. Thus Mills has said‡—"Substantially satisfactory evidence has been adduced that there is no material loss during the evaporation." The experiments now reported prove exactly the reverse of this, and furnish for the first time, as far as I know, direct evidence of the fact that, for some organic substances at least, and those of a kind liable to occur among the products of putrefaction, there is material, nay very great, loss.

As regards the frequently presented excess of nitrogen, I am strongly inclined to believe it, in part at least, due to absorption, during the evaporation of the acidified water, of ammonia *from the atmosphere surrounding the gas flame* and water-bath. Due care was taken as to the general condition of the atmosphere of the room, and it hardly seems possible to account for the error from this source.§ But anyone who has noticed the considerable deposit of ammonium sulphate formed on platinum vessels over an ordinary laboratory lamp, or on bells suspended over household gas-lights, will readily admit that here is a manifest source of danger. The extent to which ammonia is removed from coal-gas at different works, and in the same works at different times, varies no doubt a good deal, but all American gas which

* See Mills's conclusions from a much more limited basis of induction furnished by a few of Frankland's analyses.—*Journ. Chem. Soc.* (Lond.), February, 1878; 58 *et seq.*

† *Journ. Chem. Soc.* (Lond.), January, 1879; 56.

‡ In this calculation hydrogen has been taken as converted into water, carbon into carbon dioxide, and nitrogen as evolved in uncombined form: of course no one would expect any such ultimate results of oxidation from the action of the permanganate as practically applied. Frankland, in a similar calculation (*Journ. Chem. Soc.*, Lond., March, 1868; 83), seems to have taken the nitrogen as oxidised to nitric acid.

* Fresenius and Scherer have found butyric and propionic acids in the mineral water of Brückenau and Weilbach. *Zeitschrift für Anal. Chem.*, 20; 3; 325.

† Wanklyn asserts in the most positive way the occurrence of loss, but gives no experimental evidence in support of his assertion. ("Water Analysis," London, 1879; 190.)

‡ *Journ. Chem. Soc.* (Lond.), February, 1878; 58.

§ The most scrupulous pains, too, were taken to guard against leakage of air into the Sprengel vacuum and nitrogen from the cupric oxide, and errors from these sources could scarcely have failed to be detected. They were examined into over and over again.

I have examined readily shows its presence. With the gas in use at the University of Virginia and the neighbouring town of Charlottesville, I find that when not ignited it will in five seconds produce a distinct yellow stain on a drop of the Nessler reagent upon white filtering paper, and, although no doubt much ammonia undergoes combustion when the coal-gas itself is burning, a platinum capsule of 3 inches in diameter, containing water to keep it cool, will, if held over the flame of a Bunsen burner for half a minute, and the outside surface then washed off into a test glass, yield a liquid which distinctly gives the Nessler reaction for ammonia. During the many hours of the evaporation of a water sample there must occur in the atmosphere about the water-bath a quantity of nitrogen in the form of ammonia which may well be called very large in comparison with the amounts dealt with by the water analyst, and although contact of the contents of the glass dish with this atmosphere is largely cut off by the glass shade, such contact is not entirely prevented, as there is the notch in the rim of the water-bath for the passage of the feed-flask neck. The avidity with which such ammonia as may reach the acid water will be absorbed by it is obvious enough, even though some be afterwards lost by dissociation. The excess of nitrogen observed in the analyses of Class IX. seems to be general; even in those cases in which a loss is recorded it will be noticed that this loss is always less than for the carbon of the same substance, and the result is most probably a mere balance between two errors in opposite directions, actual loss of organic nitrogen volatilised in some form during the evaporation of the water, very possibly to even a greater extent than for carbon, and on the other hand absorption of nitrogen as ammonia from the atmosphere.

(To be continued.)

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 3, July 17, 1882.

Lightning Rods.—M. Melsens.—The author defends his system of lightning rods, which consists of a kind of cage formed of multiple conductors. He refers to an experiment which has been considered capital by many physicists and which supports those of Faraday, proving that no electric manifestation is possible in a cage with continuous metallic sides, or metallic meshes, placed in perfect communication with a common reservoir. Any animal is placed in a hollow sphere of metallic links, placed upon or suspended from the coating of a strong Leyden battery. The attempt is then made to strike the animal by the discharge of the battery, but it experiences no action from a spark which would have been dangerous or mortal if it were not protected by the cage. In this experiment the metallic cage represents the author's lightning rod, and the animal within represents a house with its inhabitants and the inflammable matter which it may contain.

Hydrated Hydrogen Sulphide.—M. de Forcrand.—With reference to the memoir of MM. Cailletet and Bordet (*Comptes Rendus*, July 10), the author points out that he has previously indicated the formation, composition, &c., of the hydrate in question in a note presented to the Academy in April (*Comptes Rendus*, xciv., p. 967), and which now appears in detail in the *Annales de Chimie et de Physique*. He has produced compounds of the same order by the union of water, hydrogen sulphide, and a number of organic substances.

Limits of Nitrification of Cellulose.—M. Vieille.—The author has experimented on the results obtained by treating cotton with nitric acid at different degrees of concentration. A very slight decrease in the specific gravity of the acid greatly modifies the nature of the product. The limits between which he obtained compounds capable of yielding collodion are very narrow. Trinitro-cellulose is completely soluble in acetic ether, and completely insoluble in a mixture of alcohol and ether. The collodion cottons are readily soluble in both, whilst the lower compounds are unaffected by both, behaving in this respect like crude cellulose.

Influence of the Compressibility of Elements on the Compressibility of the Compounds into which they enter.—L. Troost.—The variation of the coefficient of compressibility of the vapour of iodine recurs in that of mercury iodide.

Derivatives of the Cuprous Sulphites.—A. Etard.—The author recently described two simple isomeric cuprous sulphites, establishing their differences by their physical properties. He now studies their chemical properties, and finds them connected with two distinct series of double salts.

Gastric Juice.—P. Chapoteau.—The author examines a white pulverulent body obtained by mixing the aqueous solution of the gastric juice with an equal volume of alcohol at 95°. This body, which ought to be called pepsine, is found in the gastric juice as a potassium salt.

Products of the Distillation of Colophonium.—A. Renard.—By operating upon large quantities of the crude essence, the author has extracted a superior homologue of heptene, which passes over between 129° and 132°, and which when purified may be represented by the formula C_8H_{14}. This carbide the author names octene.

A New Class of Cyanic Compounds with an Acid Reaction, Cyano-malonic Ether.—A. Haller.—The compound is colourless, of a pungent odour, and an acid reaction. If exposed to the air, it turns slightly reddish. It is slightly soluble in water, to which it gives an acid reaction, and is soluble in alcohol, ether, and alkaline solutions. It decomposes carbonates with escape of carbonic acid. Its formula is $C_8H_{11}NO_4$. The author has prepared a number of its salts.

Two New Antiseptics, Calcium and Sodium Glycoborates.—G. Le Bon.—The author asserts that these bodies whilst being powerfully antiseptic have the properties of being very soluble, inodorous, and not poisonous. Thus they may be employed for the preservation of articles of food.

Industrial Conditions of the Application of Cold for the Destruction of the Germs of Parasites in Alimentary Substances.—F. Carré.

Verhandlungen des Vereins zur Beförderung des Gewerbfleisses. Supplemental Volume, 1882.

This volume contains a lengthy survey of the special technical schools of Europe and America. Its extent, 150 quarto pages, renders abstraction impossible.

Bulletin de la Société Chimique de Paris. May 20, 1882.

Specific Heat of Hyponitric Acid.—MM. Bertholet and Ogier.—The substance of this memoir has already appeared in the *Comptes Rendus*.

Industrial Residue Rich in Selenium, and a New Process for its Extraction.—M. P. Kienlen.—Amongt the secondary products from which selenium is extracted, the text-books mention especially the flue-dust from metallurgical works in which seleniferous ores are treated, and the deposits formed in the lead-chambers where pyrites are burnt containing traces of selenium. Another

residue rich in selenium is the deposit formed in the Wolff's bottles in which hydrochloric acid is condensed. It is derived from the volatilisation of the selenium contained in the sulphuric acid used for the decomposition of the salt. In large chemical works the acid generally employed for this purpose is that which flows from the Glover tower, and which is rendered unfit for the production of strong acid by the presence of a large proportion of iron. In the Glover tower the selenious acid derived from the pyrites is reduced by the sulphurous acid to selenium, which is either dissolved in the acid or remains suspended. The proportion of selenium thus retained is often, in works where the pyrites of Saint Bel, near Lyon, are burnt, large enough to give a blood-red tinge to the acid. The determination of the selenium is easily effected by operating upon considerable quantities, diluting with three times their volume of water, and then allowing them to settle for a long time in a warm place. The clear liquid is then drawn off with a syphon, and the deposit of selenium is collected on a tared filter, washed, and dried at about 100°. Acid from the Glover tower (sp. gr. 1·606) has thus given per litre 28·3 m.grms. and chamber acid (sp. gr. 1·532) 34 m.grms. per litre. Selenium being volatile at dull redness is often swept away by the hydrochloric vapours during the calcination of salt-cake, and is deposited in the first condensers. The hydrochloric acid is sometimes so loaded that it presents a fine red fluorescence, and the glass connection-tubes are lined with a layer of selenium several millimetres in thickness. The mud deposited in the condensers when dried at 100° give a proportion of selenium varying from 41 to 45 per cent. The determination is effected in the following manner:—20 grms. of dried mud are placed in a long-necked flask, stirred up in water, and mixed with caustic soda-lye till the reaction is slightly alkaline. Bromine is then added drop by drop, shaking continually till no further rise of temperature is produced. After a time the mixture is filtered, and the filtrate, mixed with the washing waters, is heated to a boil with a small quantity of hydrochloric acid, and the selenium precipitated by sulphurous acid is collected on a tared filter and weighed. For the industrial extraction of selenium from this deposit, the mud is stirred up in water, and treated in the cold with chlorine in a series of large Wolff's bottles. The selenium is converted into tetrachloride, which in presence of water gives selenious acid, and this again is partially transformed by the excess of chlorine into selenic acid. The resulting solution is strongly acid, and contains selenious, selenic, and hydrochloric acids. When the brick-red colour has completely disappeared ftom the first bottle it is withdrawn and its place is taken by the second, whilst the last bottle receives fresh mud. The deep black liquids are filtered through felt fitted to frames, and are then raised to a boil in presence of an excess of hydrochloric acid, which reduces the selenic acid to selenious acid with disengagement of chlorine. The liquid is then made up to its original volume, and the selenium is precipitated in large stoneware vessels by means of sodium bisulphite, which is added till a strong odour of sulphurous acid is perceptible. The selenium falls in large crimson flakes, which collect into a pitchy mass with bronze reflections. It is raised to a boil by blowing in steam, and the precipitate quickly collects at the bottom of the vessel as a steel-grey mass.

Action of Aluminium upon Cupric Chloride.—D. Tommasi.—Already noticed.

Artificial Production of Crystalline Carbonates: Witherite, Strontianite, and Calcite.—L. Bourgeois.—The author obtains these bodies in crystals by the dry way, under the ordinary pressures and in certain fluxes, of which a mixture of sodium and potassium chlorides, in equal equivalents, gives the best results.

Artificial Production of Analcime.—A. de Schulten.—The author mixes solutions of sodium silicate and aluminate in proper proportions, adds a suitable quantity of lime-water, and heat for eighteen hours to 180° in a closed copper-tube.

Determination of Nitric and Nitrous Nitrogen as Ammonia.—A. Guyard.—Already noticed.

Artificial Production of a Crystalline Hydrous Silicate.—A. de Schulten.—The author has obtained a zeolite approaching in composition to okenite.

Tetranitrated Ethylen Bromide.—A. Villiers.—Already noticed.

Chloruration of Camphor: Formation of Dichlorated Camphor.—P. Cazeneuve.—Already noticed.

Physiological Action of Beta-Collidine.—MM. Marcus and Oechsner de Coninck.—This alkaloid, though derived from cinchonine, is strongly poisonous. Subcutaneous injections of 0·05 to 0·15 grm. occasion a general and progressive debility, and paralyse the action of the psycho-motor centres.

Journal für Praktische Chemie.
New Series. Vol. xxv., Part 8, 1882.

Contributions to the Chemistry of the Chrome-Ammoniacal Compounds.—S. M. Jörgensen.—The author treats here on the normal and the basic rhodochromates.

Contributions to the Chemistry of the Rhodium-Ammoniacal Compounds.—S. M. Jörgensen.—The author has had the opportunity of examining the ammoniacal rhodium compounds and finds them completely analogous with the ammoniacal compounds of cobalt and chromium. Rhodium ammonia chloride, $10NH_3R_2Cl_6$, corresponds in every respect to the chloropurpureo-chlorides of cobalt and chromium. It is insoluble in hydrochloric acid. Only four atoms of chlorine are precipitated by salts of silver in the cold, and the remaining two only on prolonged boiling. It is precipitated by nitric acid, a yellowish white chloropurpureo-nitrate being deposited. The author has demonstrated the existence of bromo-, iodo-, and nitrato-purpureo-rhodium salts as well as of roseo-and xantho-rhodium salts.

The Elementary Composition of Starch.—F. Salomon.—Pure potato-starch is composed according to the elementary formula $C_6H_{10}O_5$. The formula proposed by Naegeli must be rejected.

The Constitution of Isatogenic Ether.—H. Kolbe.—A critique on a passage of a memoir by Prof. Ad. Baeyer.

Justus Liebig's Annalen der Chemie,
Band 212, Hefts 1 and 2.

Reduction Experiments in the Anthraquinon Series.—C. Liebermann.—In this extensive memoir the author treats successively of the reduction of anthraquinon, of quinazarine, and of oxy-anthraquinon; of chrysarobine, a naturally occurring reduction-product of chrysophanic acid; the reduction of sulphanthraquinonic acid, anthrol, and anthramine; of the alkylised reduction stages of anthraquinon, the alkyloxanthrols, and their derivatives; the alkyl-hydro-anthranols, and alkyl-anthracenes. As the treatise extends to some 120 pages, no useful abridgment is practicable.

Certain Derivatives of Para- and Ortho-nitro-Cinnamic Acid.—C. L. Müller.—The author describes the preparation of nitro-cinnamic acids, the bromation of both the nitro-cinnamic esters, the treatment of para-nitro-phenyl-dibrom-propionic ethyl-ester with alcoholic potassa, para-nitro-mono-brom-cinnamic ethyl-ester, the preparation of para-nitro-phenyl-propiolic acid, the treatment of ortho-nitro-phenyl-dibrom-propionic ester with alcoholic potassa, ortho-nitro-phenyl-propiolic acid, ortho-nitro-phenyl-acetylene, the results of the reduction of ortho-nitro-phenyl-propiolic acid, *i.e.*, the production of indigo-

tine. It appears that the author made this observation without being aware that Prof. Baeyer had come upon the same reaction. It appears from the author's results that by the introduction of the nitro-group into the benzol nucleus of cinnamic acid, the tendency of the latter to combine with negative radicals, and to pass into a saturated compound, is considerably weakened. These researches were conducted during the winter term of 1879-80, and the summer term of 1880, in the Laboratory of the Technical High School at Munich, and were laid before the Philosophical Faculty of the University of Freiburg, in December, 1880, as an Inaugural Dissertation.

Derivatives of Para-nitro-cinnamic Acid.—V. B. Drewsen.—This memoir contains accounts of para-nitro-cinnamic acid, of its dibromide, the dibromide of para-nitro-cinnamic ethyl-ether, para-nitro-phenyl-propiolic acid, its dibromide, the dibromide of its ethyl-ether, para-nitro-phenyl-acetylene, para-nitro-aceto-phenon, and para-amido-aceto-phenon.

Cotarnine (Second treatise).—E. von Gerichten.—We have here an account of tarconic acid, tarnine, nartine, nartinic acid, methyl-brom-tarconium-iodide, ethyl-brom-tarconium-iodide, the action of hydrated baryta upon methyl- and ethyl-brom-tarconium-iodide, and upon the hydroxides corresponding to these iodides, methyl-brom-tarconic acid, ethyl-brom-tarconic acid, and cupronine.

Combinations of the Elements of the Nitrogen Group with the Radicles of the Aromatic Series.—A. Michaelis.—In this fifth treatise the author, with the assistance of Cl. Paneck, discusses the homologues of phosphenyl chloride, the tolyl-phosphorus chlorides, para- and ortho-tolyl-phosphor-tetra-chlorides, para-tolyl-phosphor-oxy-chloride, tolyl-phosphinous acid with its salts, benzo-phosphinous acid, the xylyl-phosphor-compounds, including xylyl-phosphor-chloride and xylyl-phosphinous acid.

Communication from the University Laboratory of Würsburg.—This consists of a memoir by J. Wislicenus on the evaluation of the adhesive energies of the halogens and sodium to organic residues. The following are the chief conclusions reached: With the equal organic residues the adhesive energy of chlorine is the greatest, and that of iodine the smallest. Among the compounds of the same halogen with isomeric radicles, the primaries have the smallest, and the tertiaries the greatest powers of adhesion. The adhesive energy of iodine, and doubtless of the other halogens, to alcohol radicles of the same category increases with increasing molecular weight.

Preparation of Ethylen-diamine and certain of its Properties.—Communicated by K. Kraut from the experiments of O. Rhousopoulos and F. Meyer.—Ethylen-diamine hydrate does not mix with benzol and ether, and cannot be withdrawn from its aqueous solutions by means of ether. The boiling-point is 118°, and the sp. gr. 0·970 at 15°. In freezing mixtures it congeals to a crystalline mass, which melts at +10°. Its composition may be represented by—$C_2H_4(H_2N)_2H_2O$.

Journal de Pharmacie et de Chimie.
June, 1882.

Action of Potassium Cyanide upon Potassium Trichloracetate.—E. Bourgoin.—Already noticed.

Chloruration of Camphor: Formation of Camphor Bichloride.—P. Cazeneuve.—Already noticed.

Caffeine.—M. Tanret.

Purification of Zinc Sulphate.—H. Prunier.—The author peroxidises the iron present by means of potassium permanganate. To ascertain the quantity necessary, he dissolves 10 grms. of copperas in water slightly acidulated with sulphuric acid, and pours into this liquid a solution of permanganate (1-1000th) until a permanent rose tint is produced. Suppose that the 10 grms. of copperas have consumed 22 c.c. of the permanganic liquid, or 0·022 grm. of potassium permanganate. If we wish to purify 100 grms. of zinc sulphate, we must dissolve these 100 grms. in 200 of water, add 0·22 grm. permanganate also dissolved in water, and complete the precipitation of the manganese and the iron by pouring into the mixture liquid ammonia diluted to 1-10th, so as to form a little zinc oxide; 5 c.c. are sufficient. The whole is boiled for some minutes, let settle, and if the supernatant liquid is not quite colourless a few more drops of dilute ammonia are added. It is then boiled again, let cool, filtered, and the filtrate concentrated, avoiding a boiling heat.

Detection of Lead in Tin Paper.—A drop of concentrated acetic acid is let fall upon the suspected leaf, and a drop of a solution of potassium iodide is added. If there is lead present there is formed in two or three minutes a yellowish spot of lead iodide. Kopp moistens the leaf to be examined with sulphuric acid. If the tin is pure the spot remains white, but if lead is present there is formed a black spot.

Malic Acid in the Berries of the Mountain Ash.—E. Johanson.—These berries are richest in malic acid when of a yellowish orange colour. When still green or when fully ripe the proportion is less.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., April, 1882.

Memoir on Hydrocellulose and its Derivatives.—Aimé Girard.—Under the influence of acids, both mineral and vegetable, both dilute and concentrated, and in variable conditions of temperature and time, cellulose, $C_{12}H_{10}O_{10}$, before becoming saccharified, and even before taking the state of soluble cellulose, is transformed into a new compound, $C_{12}H_{11}O_{11}$, exceedingly friable, but retaining many of the properties of normal cellulose. The conversion is most easily effected by immersion for twelve hours in sulphuric acid at sp. gr. 1·420. The author remarks that Mercerised fibres present the same physical state as those treated with acids. Hydrocellulose possesses special tinctorial aptitudes. It takes up readily colours which can only be fixed upon normal cellulose with great difficulty.

Normal Carbonic Acid of the Atmosphere.—M. Dumas.—The author, whilst admitting that the proportion of carbonic acid in the atmosphere varies little from 3 parts in 10,000, proposes systematic determinations made at different points of the globe.

Rational Method for the Study of Dyeing.—M. Decaux.—(See p. 51).

May, 1882.

This issue contains no chemical matter.

Annales de la Société des Sciences Industrielles de Lyon. No. 1, 1882.

Note on the Manner of Determining the Composition of Tissues made of Different Fibres.—H. Danzer.—The author separates animal from vegetable fibre by the well-known process of boiling with a caustic alkaline lye.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Extracting Tannin.—Can any correspondent inform me of an economical process of extracting tannin from barks so as to save bulky carriage?—Bala, Merionethshire.

THE CHEMICAL NEWS.

VOL. XLVI. No. 1186.

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Cobalt.—However slight the proportion of cobalt, caustic potassa does not give very good results in consequence of the relatively considerable entanglement of gallium in the oxide precipitated. Sensible traces of gallium may be detected in cobalt oxide which has been precipitated with an excess of potassa five times in succession, and this when operating upon a liquid containing merely 0·005 grm. gallium in 2 to 3 grms. of cobalt oxide. Yet, after the seventh potassic treatment, there no longer remains any gallium in the oxide of cobalt. The process is therefore only fit for removing small quantities of cobalt mixed with much gallium; the small precipitate of cobalt oxide is then freed from the last traces of gallium by one of the other methods. The potassic filtrates often retain a trace of cobalt, which tinges them blue; exposure to the air decolourises these solutions in one or two days in the cold, or in one hour with heat, brown cobalt oxide being deposited.

Barium and calcium carbonates effect at first merely an imperfect separation of gallium and cobalt. Even in the cold, after a contact of six hours, the precipitates contain notable quantities of cobalt oxide. Contrary to what happens with the salts of zinc, the author finds a little more cobalt oxide in the precipitate with the calcium than in that with the barium salt. The inconvenience of the precipitation of a certain quantity of cobalt oxide in presence of barium and calcium carbonates is diminished by the separation which is naturally effected between gallium and cobalt, when ammoniacal boiling or treatment with cupric hydrate are employed to eliminate calcium and barium salts.

In the reaction of calcium carbonate in heat, after sulphurous reduction, there are also deposited notable quantities of cobalt oxide, which, nevertheless, are entirely eliminated if the operation is repeated once or twice, and also on ammoniacal ebullition or treatment with copper hydrate for the removal of lime. Prolonged boiling after supersaturation with ammonia enables us to separate very conveniently gallium from cobalt. It is necessary to operate upon a very acid liquid, so as to produce a sufficient quantity of ammonium chloride, taking care to boil previously, so as to destroy the per-salts of cobalt. The ammonia is not added until after the liquid has begun to boil. The purpureo-cobaltic salts which are sometimes formed in small quantity, are dissolved and carried away in the washing waters. The gallium oxide thus obtained retains almost always traces of cobalt, which are eliminated on repeating the operation.

Excellent results are obtained either by means of cupric hydrate or of metallic copper and cuprous oxide. Sensible traces of cobalt, however, remain in the first copper precipitates; but they are easily removed by one, or at most, two repetitions.

Separation from Nickel.—Nickel oxide precipitated by an excess of boiling potassa retains gallium more energetically than does cobalt oxide. With a liquid containing 0·005 grm. gallium and 2 to 3 grms. nickel oxide, a very notable proportion of the gallium is found in the precipitate after the seventh treatment with potassa. This procedure is consequently applicable only in case of a small quantity of nickel mixed with much gallium. The galliferous nickel oxide is then analysed by one of the other procedures.

If we have mixtures containing little gallium and a large mass of protoxides, such as those of cobalt, nickel, manganese, zinc, &c., it is almost always very advantageous to begin by precipitating at a boil all the gallium sesquioxide by means of an alkali, along with a small fraction of the protoxides. The detection of the gallium becomes then easier, since it bears upon a small bulk of matter. The action of calcium and barium carbonates in the cold, as well as that of calcium carbonate in heat after sulphurous reduction, require the same remarks as in case of the separation from cobalt. The author has likewise found that a little more nickel oxide is rendered insoluble with calcium carbonate than with barium carbonate.

A good separation is obtained by boiling with ammonia. The original hydrochloric solution ought to be very acid. Especially if the nickel is abundant the precipitate contains quantities of it not to be neglected. It is removed by repeating the same process once or twice. Cupric hydrate, as well as metallic copper and cuprous oxide, are excellent reagents to employ. The traces of nickel oxide carried down in the precipitates in the first operation are eliminated on repeating it once or twice.

Separation from Thallium.—This separation is not effected satisfactorily by precipitating the alcoholic solution with potassium iodide; thallium remains in the filtrate and sensible traces of gallium in the deposit. It is not more advantageous to reduce the thallium to the metallic state by means of a sheet of zinc. There are thus introduced into the analysis the impurities so frequently contained in zinc, and the thallium carries down gallium, unless the liquid is kept sufficiently acid, but then the precipitation of the thallium is incomplete. The eight following procedures may be recommended, though in different degrees:—

1. Boiling after supersaturation with ammonia gives good results with thallium sulphate, chloride, or nitrate, if slightly acid. The salts must be previously reduced to the lowest stage of oxidation by the addition of a few drops of a solution of sulphurous acid. If slight traces of thallium remain in the precipitate they are entirely eliminated by repeating the boiling with ammonia; the gallium oxide obtained then gives no spectroscopic indication of thallium.

2 and 3. Calcium and barium carbonates precipitate gallium in the cold without rendering the thallium insoluble beyond slight traces, which disappear entirely during the operations for removing the lime or baryta. Before adding the carbonates the liquid is reduced by means of sulphurous acid.

4. Calcium carbonate may be used in heat after reduction by means of sulphuric acid. There are sensible traces of thallium in the precipitate, but they are subsequently eliminated along with the lime.

5 and 6. Cupric hydrate, as also metallic copper and cuprous oxide, are the best reagents, for the gallium is totally precipitated without carrying down a trace of thallium. If cupric hydrate is employed, the thallium salts must previously be reduced to the lowest stage of oxidation by means of sulphurous acid.

7. If the quantity of thallium is not too considerable, so that its chloride remains dissolved, gallium may be precipitated by potassium ferrocyanide in a very acid solution and at a temperature of 70°. Traces of thallium contaminate the deposit, which is re-dissolved in a small excess of potassa; there are added to the liquid a few drops of ammonium hydrosulphate recently prepared, and the whole is filtered to separate thallium sulphide. The clear solution is evaporated to a small bulk, supersaturated with a large excess of hydrochloric acid, and mixed with a little ferrocyanide. The slight traces of gallium carried down by the small quantity of thallium sulphide may generally be neglected. If needful they may be separated by known methods.

8. Thallium may be thrown down by platinum chloride from an alcoholic solution, acidified with hydrochloric acid. A prolonged current of sulphuretted hydrogen removes the platinum contained in the liquid, from which is

afterwards obtained gallium containing merely traces of thallium. The chloro-platinate, suspended in water acidified with hydrochloric acid, is treated with hydrogen sulphide, which renders the platinum insoluble. The salt of thallium obtained does not contain sensible traces of gallium.—*Comptes Rendus.*

ON CERTAIN SUBSTANCES OBTAINED FROM TURMERIC.

I.—CURCUMIN.*

By C. LORING JACKSON and A. E. MENKE.

(Concluded from p. 62.)

Properties of Curcumin.

Curcumin crystallises from alcohol in stout needles, which under the microscope appear as well-formed prisms with square ends, or spindle-shaped crystals, often arranged in radiating groups; in colour it is orange to yellow, according to the size of the crystals, with a beautiful blue reflex; its solution in ether exhibits a very strong green fluorescence; when pure it has no odour; it melts at 178°, apparently with decomposition.† It is nearly insoluble in water, somewhat soluble in cold, more readily in hot alcohol and methyl alcohol, more soluble in glacial acetic acid than in alcohol, less so in ether, very slightly soluble in benzol‡ and carbonic disulphide, and essentially insoluble in ligroine. Strong sulphuric acid dissolves it with a fine reddish purple colour, which changes to black from charring after some time; strong hydrochloric acid produces the same effect, but with more difficulty. It is readily soluble in alkalies and alkaline carbonates, and is even dissolved to a slight extent when boiled with precipitated calcic carbonate and water. The solution in ammonic hydrate loses ammonia when boiled, and deposits unaltered curcumin. A solution of baric hydrate converts it into a blackish red powder, but lime-water gives a red solution like that obtained from calcic carbonate. It is not affected by acid sodic sulphite.

Salts of Curcumin.

In taking up the study of this subject we were at first attracted to the lead salt by the analyses and descriptions of Ivanow-Gajewsky and Daube; but, after several experiments, we decided that it was too indefinite a substance to throw much light upon the nature of curcumin, and accordingly turned our attention to the potassium salts, which at first did not seem promising, but on proper treatment have yielded satisfactory results. Before describing these, however, we will say, that there seem to be at least two lead salts, as we have obtained a dark claret precipitate and also a flame-coloured one. The most promising method of preparation seemed to be boiling curcumin with precipitated calcic carbonate and water, and adding plumbic acetate to the filtrate; in this way the flame-coloured salt was obtained.

We have succeeded in obtaining two potassium salts, containing one and two atoms of potassium respectively.

Dipotassic Salt of Curcumin, $K_2C_{14}H_{12}O_4$.

This was made by adding a large excess of a strong alcoholic solution of potassic hydrate to a hot saturated solution of curcumin in alcohol; if the solutions are strong enough, flame-coloured crystals of the salt are deposited on cooling; if this is not the case, it can be precipitated by addition of ether. If an insufficient amount of potassic hydrate is used, a dark red solution of the mono-potassic salt is formed, which becomes lighter on the addition of more potassic hydrate as the second atom of potassium is taken up. The salt was crystallised from boiling alcohol, to which a few drops of ether had been added, washed with a mixture of alcohol and ether, then with ether alone, pressed on filter-paper, and dried as rapidly as possible in a steam-drying closet containing some potassic hydrate.

0·7168 grm. of the salt gave, heated with sulphuric acid, 0·3824 grm. of K_2SO_4.

0·2675 grm. gave 0·1459 grm. of K_2SO_4.

	Calculated for $C_{14}H_{12}K_2O_4$.	Found.	
Potassium ..	24·27	23·95	24·48

If curcumin had the formula $C_{16}H_{16}O_4$ the dipotassic salt would contain—

Potassium .. .. 22·46

The salt consists, when first formed, of flame-coloured needles in globular radiating groups, but becomes deep claret on drying. It is freely soluble in water, not quite so soluble in alcohol, and essentially insoluble in ether; the alcoholic solution takes on a magenta colour when exposed to the air, and the salt seems to absorb carbonic dioxide readily, although the change of colour was more probably due to oxidation.

Mono-potassic Salt of Curcumin, $KC_{14}H_{13}O_4$.

If an excess of potassic carbonate is added to a hot solution of curcumin in absolute alcohol, there is a violent effervescence, and the liquid turns deep blood-red. After slight concentration the excess of potassic carbonate was removed by filtration, the salt precipitated with ether, and purified by washing with ether. An attempt to crystallise it from a mixture of alcohol and ether gave no satisfactory result. Pressed between filter-paper, and then dried at 100°, it gave the following results:—

I. 0·4808 grm. of the salt gave after ignition with sulphuric acid 0·1540 grm. of K_2SO_4.

II. 0·5381 grm. of salt gave 0·1680 grm. of K_2SO_4.

	Calculated for $KC_{14}H_{13}O_4$.	Found.	
		I.	II.
Potassium ..	13·76	14·36	14·02

$KC_{16}H_{15}O_4$ contains 12·60 per cent of potassium.

This salt is precipitated in crimson black flocks, which dry to a mass having the green colour and lustre of rosanilin, although the shade is somewhat blacker. It is very easily soluble in water and alcohol, giving blood-red solutions, but insoluble in ether, and does not seem to be altered by exposure to the air. It can also be made by the action of an excess of curcumin on the dipotassic salt, or by adding potassic hydrate not in excess to curcumin suspended in alcohol. It is very much more soluble than the dipotassic salt.

Curcumin forms also a flame-coloured calcium salt, slightly soluble in water, which can be made by adding calcic chloride to a solution of the mono-potassic salt. The same salt is formed in small quantity when calcic carbonate is boiled with curcumin and water or alcohol, carbonic dioxide being set free.

The zincic salt seems to be soluble, the baric salt insoluble,* while the silver salt is probably very unstable, as curcumin is decomposed when boiled for more than a minute with argentic nitrate and alcohol.

The fact that only one atom of the hydrogen contained in curcumin can be replaced by the potassium of potassic carbonate would point to the existence of one, and only one, carboxyl group in its molecule; the presence of this group is confirmed further by the power of decomposing calcic carbonate possessed by curcumin.† The replacement of a second atom of hydrogen when curcumin is

* From the *Proceedings of the American Academy*. Communicated by the Authors.

‡ Daube found 164°; Gajewsky, 172° or 140°.

‡ Compare Daube, *Ber. Deut. Chem. Ges.*, 3, 609.

* As our work on the potassium salts had achieved the end for which we undertook the study of the salts of curcumin, we thought it not worth while to purify any of the other salts for analysis.

† Some experiments on the action of phosphorus trichloride upon mono-ethyl-curcumin confirmed the presence of a carboxyl group, so far as they went, but the product was too ill-defined to repay a thorough study.

treated with potassic hydrate in excess indicates the existence of a hydroxyl group, probably a phenol hydroxyl, and it would seem, therefore, that curcumin is a diatomic mono-basic acid.

Esters of Curcumin.

Although the analyses of the potassium salts had agreed with the formula of curcumin derived from the analysis of the original substance, it seemed desirable to confirm this formula still further by the study of some derivative of curcumin more stable and easily handled than the salts; we accordingly took up the investigation of the esters, but found that the ethyl-ester made by the action of ethyl-iodide on the dipotassic salt, was a disagreeable brownish black tarry substance, that could not be obtained in a crystalline condition. We therefore abandoned the study of this substance and turned our attention to the mono-para-brom-benzyl-ester, which we preferred to the benzyl-ester, in the first place because of the great tendency of the para-brom-benzyl compounds to crystallise, and secondly, since the presence of bromine increased the difference between the percentages of carbon in the two formulæ by more than five-tenths of 1 per cent, and also gave a third element whose quantity could be determined.

Mono-para-brom-benzyl-ester of Curcumin, $C_{14}H_{13}(C_7H_6Br)O_4$.

To an alcoholic solution of the mono-potassic salt of curcumin an excess of para-brom-benzyl-bromide was added, and the mixture allowed to stand for several days, when it was found that pale yellow crystals mixed with potassic bromide had been deposited; the dark-coloured liquid was poured off, and the solid residue freed from para-brom-benzyl bromide by repeated treatment with hot ligroine, and from curcumin by boiling with successive portions of aqueous potassic carbonate, until it ceased to give a red solution. The essentially pure ester thus obtained was boiled several times with alcohol, which dissolved a small portion of it, while the residue melted to a reddish black tar; upon dissolving this in glacial acetic acid and precipitating with water, yellowish flocks were thrown down, the melting-point of which was compared with that of the similarly-coloured indistinct crystals obtained by cooling the alcoholic extract. As both these substances melted, or, more accurately, drew together, at the same temperature, the ester seemed to be essentially pure, and after drying at 50° to 60° was analysed.

I. 0·1796 grm. of substance gave 0·3980 grm. of CO_2 and 0·0817 grm. of H_2O.

II. 0·2506 grm. of substance gave according to Carius 0·1156 grm. of AgBr.

	Found.	Calculated for $C_{14}H_{13}(C_7H_6Br)O_4$.	Calculated for $C_{16}H_{15}(C_7H_6Br)O_4$.
Carbon ..	60·43	60·72	62·58
Hydrogen	5·05	4·57	4·76
Bromine	19·63	19·26	18·14

From these results there can be no doubt that $C_{14}H_{14}O_4$ is the true formula of curcumin.

The ester consists of indistinct crystals, grouped in forms like cauliflowers, of a much paler yellow colour than curcumin; it melts at 76° to 78°, beginning to draw together at 76°, and becoming thoroughly liquid at 78°; we have not succeeded in obtaining it with a perfectly sharp melting-point. It is more soluble in glacial acetic acid than in alcohol; nevertheless the latter is to be preferred as a solvent for obtaining crystals, since the substance is apt to separate from the hot glacial acetic acid in a fused tarry condition. It is readily soluble in ether and benzol, but does not crystallise well from these solvents; slightly soluble in carbonic disulphide; essentially insoluble in ligroine; not attacked by a solution of potassic carbonate, but soluble in potassic hydrate, although without the red colour characteristic of curcumin. As the analysis of this ester establishes our formula, we have not continued the study of the esters.

Oxidation of Curcumin.

Our experiments on this subject can be divided into two classes, those in which we made a complete oxidation of the substance, and those in which a partial oxidation was obtained by using an insufficient amount of the oxidising agent, or one less energetic.

Complete Oxidation.—As Ivanow-Gajewsky states that he obtained terephthalic acid by the action of potassic dichromate and sulphuric acid on curcumin, we turned our attention first to this experiment. Unfortunately only an abstract of his paper is accessible to us, so that we could not find the exact conditions of his oxidation; we have therefore varied the conditions in several ways, but always with the same result. It will be sufficient to describe a single experiment. Half a grm. of curcumin was mixed with sulphuric acid previously diluted with its own volume of water, and solid potassic dichromate added; the action was extremely violent, accompanied by great evolution of heat and strong effervescence; the gas given off was carbonic dioxide. At the end of the process there was no insoluble substance in the liquid, which was therefore distilled until it was reduced to a small volume. The strongly acid distillate, treated with argentic oxide, after filtering and concentration, deposited long flattened needles, which looked exactly like argentic acetate, and were proved to consist of this substance by the following silver determination:—

0·1812 grm. of salt dried at 100° gave 0·1559 grm. of AgCl.

	Calculated for $AgC_2H_3O_2$.	Found.
Silver	64·68	64·76

There was no other volatile acid in the distillate, and no organic matter could be found in the residue from the distillation. If the action was moderated by using more dilute sulphuric acid, the phenomena were the same, except that it was necessary to start the reaction by the aid of heat. In none of the products of the oxidation of curcumin with potassic dichromate could any terephthalic acid be found; they consisted only of acetic acid and carbonic dioxide.

If curcumin is dropped into fuming nitric acid it dissolves with a hissing noise and formation of nitrous fumes and hydrocyanic acid. The red liquid thus obtained gave no precipitate with water; on evaporation it deposited brownish crystals, principally oxalic acid, but it was not further examined. In this respect we confirm the results of Daube, who also obtained oxalic acid from curcumin and nitric acid.

Incomplete Oxidation.—When curcumin was dissolved in aqueous potassic hydrate, a solution of potassic permanganate added, not in excess, and after the oxidation had ceased, the liquid acidified with sulphuric acid, a strong smell of vanilla was observed. The liquid was accordingly filtered, and the precipitate thoroughly washed with boiling water, the filtrate and wash-water extracted with ether, and the extract treated with acid sodic sulphite, as directed by Tiemann and Haarmann.* The product was an oil, having a strong smell of vanilla and gradually solidifying in circular groups of radiating needles; the amount, however, was extremely small, and none of this product was obtained with an excess of potassic permanganate or when the quantity of curcumin was much more than half a grm. The same substance was obtained with various weak oxidising agents, such as bleaching-powder and water, potassic ferricyanide with potassic hydrate, and even the action of atmospheric oxygen on curcumin dissolved in potassic hydrate. Of these the mixture of potassic hydrate and potassic ferricyanide gave the best yield, but even this was extremely small—in fact, after uniting the product from all the oxidations made by us, in which over 8 grms. of curcumin were used, the

* *Ber. Deut. Chem. Ges.*, 8, 1115.

quantity was not enough for complete purification. By sublimation, however, and subsequent crystallisation from boiling water, it was obtained in white needles resembling in appearance and odour the vanillin from the vanilla-bean, and melting at 79°. Vanillin melts at 80° to 81°.

In addition to the vanillin there were formed carbonic dioxide, a black amorphous substance with feebly acid properties, perhaps the aldehyd resin of vanillin, as it appeared in largest quantity when no vanillin was obtained, and an acid volatile with steam. We have not as yet made any complete study of these secondary products, because the properties of the humus-like substance are far from inviting, and the amount of the volatile acid is so minute that its isolation in quantity sufficient for analysis would be extremely laborious. We shall, however, return to these substance if we fail in finding easier methods for studying the nature of the side-chain.

As the small yield of vanillin was undoubtedly due to the presence of the phenol hydroxyl, which offered a point of attack for the oxidising mixture, we next tried to increase our yield by replacing the hydroxyl hydrogen with some radical which would protect it from oxidation, and in this way not only prove that the substance was really vanillin, but also that it was one of the principal products of the oxidation. For this purpose we first tried to make acetyl-curcumin by treating curcumin with acetyl-chloride; this gave a deep bluish green liquid, which on standing turned brown, and then yielded on addition of water a yellowish precipitate which could not be obtained in crystals, its solutions forming on evaporation a dark-coloured varnish. With acetic anhydride no better results were obtained, and as there seemed no prospect of getting a good analysis of the substance, it was at once oxidised with potassic permanganate. The result was not essentially better than that obtained with pure curcumin, and we accordingly turned our attention to the oxidation of diethyl-curcumin, which was made by boiling the dipotassic salt with absolute alcohol and a slight excess of ethyl-iodide for six hours in a flask with a return cooler. On distilling off part of the alcohol and allowing the rest to evaporate spontaneously, the compound is left as a most uninviting brownish black tar, which when heated with sodic hydrate dissolves with a dark red colour resembling that of the alkaline solution of curcumin. Upon treating this solution with potassic permanganate until it was decolourised, filtering from manganic hydrate, and acidifying with sulphuric acid, a yellowish precipitate was obtained, which after two crystallisations from boiling water with bone-black melted at 195°, the melting-point given by Wassermann* for ethyl-vanillic acid (Tiemann† gives 193° to 194°).

The nature of the substance was still further confirmed by the following combustion:

0·1216 grm. of substance gave 0·2714 grm. of CO_2 and 0·0707 grm. of H_2O.

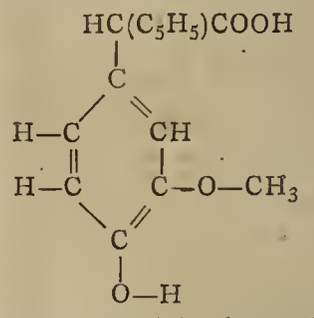
	Calculated for $C_{10}H_{12}O_4$.	Found.
Carbon	61·22	60·87
Hydrogen..	6·12	6·46

There can be no doubt, therefore, that the substance is ethyl-vanillic acid, and it was formed in such quantity that it must be considered one of the principal products of the reaction. If the potassic permanganate was not added in excess, and the liquid extracted with ether, crystals of ethyl-vanillin were obtained, which on sublimation formed an oil solidifying after a short time in large twinned crystals like those of cassiterite, and having a smell similar to that of vanillin, but not identical with it.

Summary of Results.

The formula of curcumin is $C_{14}H_{14}O_4$, as proved by analyses of curcumin itself, of its potassium salts, and its para-brom-benzyl-ester.

It is a phenol-carboxylic acid, as shown by the study of its salts. The presence of carboxyl is indicated by its power of driving carbonic acid out of potassic and calcic carbonates, and by the decomposition of its diethyl-ester on boiling with potassic hydrate. It contains the vanillin group, and therefore its formula, as far as we have determined it, is:—



We are at present engaged in the study of the group C_5H_5, and propose to extend our investigations to rosocyanin and the turmeric oil.

THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.*

By Prof. J. W. MALLET, F.R.S., University of Virginia.

(Continued from p. 66.)

In reference to the results obtained by the albumenoid-ammonia process, little more is presented than has already been fully discussed in an earlier part of the general report. The total loss of the amine bases by volatilisation during the first distillation (with sodium carbonate) results practically, as these bases do not produce the ammonia colour with the Nessler reagent, in their nitrogen escaping recognition under the head of either "free" or "albumenoid" ammonia. Here we have a proof that some, at least, of the nitrogenous products of putrefaction are not detected or determined by this process as usually conducted.† There is no discrepancy between the results as to these bases here noticed and that recorded for a triethylamine salt in Table VII. of the general report; in this last-mentioned case the salt was in contact with alkaline permanganate from the commencement of the distillation.

The results in this Class IX. by the permanganate process have mainly the same sort of interest. It has, of course, long been known that, in the words of Tidy,‡ "there are many substances (most of which are crystalline), that are altogether unacted upon, or very slowly acted upon, by the oxygen of permanganate"; but it has been distinctly claimed for this process§ by the same chemist that "it undoubtedly furnishes us with exact information as to the relative quantities of putrescent and easily oxidisable matter, and of non-putrescent or less easily oxidisable matters, present in the water. The former (viz., the putrescent organic matters) it indicates quantitatively with great accuracy; the latter (viz., the non-putrescent matters) are scarcely capable of the same exact estimation as the former, for they are bodies for the most part of difficult oxidation." Now here we have some of the definite substances which are actually known to occur among the constituents of putrescent albumenoid matter, and it needs but a glance at the table to see how limited is their oxidation by the cold acid permanganate, and yet how

* *Annalen der Chemie*, 179, 366.
† *Ber. Deut. Chem. Ges.*, 8, 1127.

* Preliminary Report on the results of an investigation, made by direction of the National Board of Health, as to the chemical methods in use.

† Wanklyn has excepted nitro-compounds and (erroneously) urea, but clearly implies that these are the only exceptions; that the nitro-compounds are without practical importance, and that urea is specially provided for.—"Water Analysis," London 1879; 189.

‡ *Jour. Chem. Soc.* (Lond.), Jan., 1879; 78.

§ *Loc. cit.*, 80.

considerable are the differences in behaviour of these few substances selected mainly on the same general principle.

Of course it is not assumed that the figures in Table XIV. really represent either the range of absolute error, or the average amount of absolute error, of the different processes as applied to the doubtless very various forms of organic matter liable to occur in natural waters. These figures do, however, illustrate the existence of sources of absolute error, and by examples taken from the very class of substances which it has been most commonly believed important to detect and determine in water analysis.

Effect on the results by the different processes of varying the extent of dilution of the same organic substances in water.—The evidence in regard to this point is graphically presented in Tables XV., XVI., and XVII.

(These tables will appear with the general report.)

In studying these tables, indications of definite effects on the results of the various processes arising from the degree of dilution of the liquids examined soon became apparent, but seemed to be subject to much irregularity. Such irregularity, however, is much reduced by a careful consideration of all the circumstances affecting individual cases. Thus, some of the numerical results of analysis ought to be omitted from consideration as vitiated by known errors, as in the case of albumenoid ammonia determinations in obtaining which the whole of the alkaline permanganate was reduced, or an obviously considerable part of the ammonia was still coming off when the process had to be stopped. In other cases the value of the results is rendered doubtful by the solution examined having been excessively dilute or excessively strong; the relatively greater analytical errors for the former, and for the latter the errors of measurement of very small quantities of the liquid itself and greater uncertainty as to its uniformity when turbid, tend to make the figures obtained less trustworthy than when intermediate degrees of concentration were involved; Nos. 110 to 118 inclusive represent the former source of abnormal results, such waters as No. 100 the latter. Again, the three solutions containing each form of polluting material in different degrees of dilution were, as has been explained, necessarily examined on different days, and evidence of changes going on in the meantime are to be found in the relative amounts of free and albumenoid ammonia, the character of the dissolved gases, &c.) see for the latter Nos. 83, 84, 85); hence the *order* in which the three solutions of each group were examined has to be taken into account. Further, the results of one of these tables have often to be considered in their bearing on those of the others, as, for instance, the free ammonia determinations as affecting the value of the figures for organic nitrogen. And, lastly, after having observed the general drift of the errors indicated, we can see in the varying balance of errors of opposite effect an explanation of many apparently exceptional figures.

The general results of such detailed study of individual cases agree with those obtained by a simple calculation of averages, omitting from the calculation such figures as on sound grounds of general principle are to be regarded as vitiated for the purpose of this discussion. In the following table the solutions of the seven pure chemicals (Nos. 141 to 161) have been left out on account of the abnormal relations of these (which have been separately discussed) to some of the processes. For the combustion process, two other substances, represented by the dilutions Nos. 101 to 103, and 122 to 124, are omitted, because in the former of these the figures for organic carbon are known to be of very little value, and those for organic nitrogen are entirely valueless in consequence of the uncertain determinations of free ammonia present in large quantity (which had to be subtracted from the gross results of analysis), while in the latter the very large amount of the free ammonia correction makes the results doubtful. For the albumenoid ammonia process, those determinations of free ammonia originally marked by Dr. Smart as uncertain (by a ?) have been omitted, and those determinations of albumenoid ammonia in making which the regular charge of alkaline permanganate was entirely reduced, requiring an additional charge to be afterwards added, or dilution to be resorted to. For the Kubel form of the permanganate process one or two cases have been omitted, in which the permanganate was entirely reduced, making the result valueless save as an approximation. Rejecting these obviously worthless data, the averages from all others are given in Table XVIII.

Table XVIII.

Average Results obtained for Different Dilutions of same Solution of Organic Matter.

	One-fifth per cent strength.		One p.c. strength.	Five per cent strength.	
	Calc.	Obtned.	Assumd.	Calc.	Obtned.
Combustion process—					
Organic carbon	20·0	17·5	100·0	500·0	549·8
Organic nitrogen	20·0	25·2	100·0	500·0	372·2
Albumenoid ammonia process—					
Free ammonia	20·0	39·9	100·0	500·0	445·3
Albumenoid am.	20·0	27·2	100·0	500·0	257·9
Permanganate process—					
Tidy method—					
Oxygen consmd in 1 hour ..	20·0	19·7	100·0	500·0	475·0
Oxygen consmd in 3 hours ..	20·0	20·0	100·0	500·0	468·9
Kubel method—					
Oxygen consmd	20·0	19·9	100·0	500·0	475·9

As regards the combustion process, we find distinct confirmation of the existence of the two forms of constant error which have been pointed out as affecting the evaporation.* The weaker the solution—or, in other words, the larger the quantity of water to be evaporated for a given amount of organic matter—the less is the amount of organic carbon obtained, indicating relatively greater loss of this element. On the contrary, the weaker the solution or the greater the quantity of water to be evaporated, the larger is the figure for organic nitrogen, indicating relatively greater gain of this element from the atmosphere, and probably in some cases less dissociation of ammoniacal salts, when the amount of free ammonia found is considerable. If the usual interpretation of Frankland C : N ratio be applied, the curious and important result of these sources of error, affecting the two elements in opposite directions, follows, that the more dilute an organically polluted water is the more animal-like in origin will its polluting material seem to be, while the stronger it is the greater will be the tendency to refer the contamination to a vegetable source. This distortion of the conclusions to be drawn from an examination by the combustion process is manifestly in the opposite direction to that commonly assumed to be safe.

In reference to the albumenoid-ammonia process, the weaker the solutions are the higher are the results obtained, both for free and albumenoid ammonia,† the influence common to both being probably that of imperfect condensation in the distillation, having a less effect as the quantity of ammonia is smaller. As for the albumenoid ammonia, the lower results obtained from the stronger solutions may be partly due to the smaller proportion borne by the fixed charge of alkaline permanganate to the quantity of organic matter to be acted on. The great irregularity in individual analyses is strongly indicative of a varying balance of errors from different sources. It will be observed that the discrepancy between the calculated

* Compare the results observed by Mills (*Jour. Chem. Soc.*, Lond., Feb., 1878; 60) in using evaporating dishes of different diameters. The larger dish gave a rather lower result for carbon, and higher for nitrogen.

† This agrees with Dr. Smart's single experiment on Washington sewage in its original form and diluted. See "remarks" on No. 116 in Table X. of General Report.

figures and those of experiment is greatest for free ammonia in the case of the weakest dilution, while the reverse is true for albumenoid ammonia.

The results of the permanganate process are shown to be much less influenced by varying dilution within the limits involved in these experiments than those of the other processes. In the case of the solutions of greatest strength somewhat smaller figures are obtained for the oxygen consumed than calculation calls for.* This is probably due to the fact that for the weaker waters the ordinary fixed charge of permanganate added at the first leaves at the close of the process a relatively larger excess than is present when successive additions of the reagent have been made to a water strong enough to reduce the first charge completely.

We must not confound the effect of varying the amount of organic matter in relation to the permanganate by which it is to be oxidised with that of varying greatly, but to the same extent, the degree of dilution of both organic matter and permanganate at the same time. Dr. Tanner's experiments showed that under the latter head a solution of even potassium nitrite might be made so dilute that its action on a correspondingly small quantity of permanganate was rendered very slow.

It may, perhaps, be said in reference to all these experiments on varied dilutions of the same materials, that the several processes under examination are intended for use on water of approximately suitable character for drinking, not on comparatively strong solutions of organic matter, such as many of those I have employed, but the answer to this objection is that these liquids were taken in order to *exaggerate*, and hence bring to light any defects inherent in the several processes, so far as such depend upon the simple condition of the amount of polluting material in proportion to that of pure water.

Special Conclusions as to the Combustion Process.

These may be briefly stated as follows:—

1. The combustion itself, carried out according to the directions of Frankland, is a process of great delicacy, and quite satisfactory in its details with proper precautions and in trained hands. There seems to be no advantage in employing any of the various modified ways of determining the gaseous products of combustion which have been proposed instead of gaseous volumetric analysis with the aid of the Sprengel vacuum.

2. The Frankland process is quite within the reach of the manipulative skill of any fairly-trained chemist, but it requires practice, and probably pretty constant practice. It cannot be taken up off-hand, and even tolerable results obtained at once. From the hands of a person without proper laboratory training its results are utterly valueless. It is hence better adapted to regular use in the examination of many samples of water in a large public laboratory than to occasional use by a private individual in now and then examining a single water.

3. The defective point in the process is the failure of the evaporation to leave a residue representing the original organic matter of the water. This, which has been hitherto more or less suspected, has been established as a fact by the investigation now reported on. The process being conducted according to the directions of its authors, there are two constantly present errors, varying, but usually important in amount, namely, loss of carbon,† and gain of nitrogen from the atmosphere, the latter probably partly balanced by loss of that originally present in the water. These errors are relatively greatest when the quantity of organic matter in the water is small.

4. These errors, affecting unequally the carbon and nitrogen, are liable to alter the statement of C : N ratio,* and hence to distort the sanitary conclusions usually drawn therefrom.

5. The result for organic nitrogen, as obtained by the combustion process, is also affected indirectly by the errors connected with the determination of the ammonia ("free ammonia"), as the nitrogen belonging to this has to be subtracted from the gross result. The existence of such errors, as from imperfect condensation of the ammonia, progressive decomposition of urea and other amides, &c., has been pointed out in previous parts of this report, and will be referred to in the conclusions as to the albumen-ammonia process.

6. There is a further indirectly operative cause of error as to the nitrogen, arising from the varying loss of ammonia by dissociation of its salts during the evaporation of the water, Frankland recognises the necessity of a correction for this, which correction he makes depend upon the amount of ammoniacal salts present, but it is almost certain that the time occupied in the evaporation will also influence the extent of loss by dissociation. Error from this source will in most cases be very small, but may affect to a not unimportant extent the result for *organic* nitrogen.†

7. The combustion process involves special difficulties in the presence of nitrates, for which difficulties no completely satisfactory remedy is as yet proved to have been found. M. W. Williams's mode of applying the copper-zinc couple for this purpose is deserving of more precise quantitative examination than it has yet received. The simultaneous presence in a polluted water of urea with nitrites and nitrates presents a case of peculiar difficulty involving several sources of error.

8. The formation of sulphuric acid during the evaporation of the water with sulphurous acid seems to be of more frequent occurrence than has hitherto been recognised. Mr. Noyes seems to think that to this source—small amounts of cupric sulphate being formed on mixture of the residue with cupric oxide—may perhaps be attributed the occasional presence, as noticed by Frankland, of traces of free oxygen among the gaseous products of combustion. This occurrence of sulphuric acid in the water residue, even in minute amount, is undoubtedly much to be deprecated, though its effect, at any rate on the carbon determinations, has not seemed to be as great as might have been expected.

9. The combustion process in its present form cannot be considered as "determining" the carbon and nitrogen of the organic matter in water in a sense to justify the claim of "absolute" value for its results which has been denied to those of all other methods. It is but a method of approximation, involving sundry errors, and in part a balance of errors.

10. There is, however, good ground for believing that in many, perhaps most, cases its results for organic carbon may, with proper precautions, be made more valuable than the indications of the permanganate process, and its results for organic nitrogen in like manner more valuable than the indications of the albumenoid-ammonia process.

Special Conclusions as to the Albumenoid-Ammonia Process.

These may be briefly summed up as follows:—

1. In the determination of both "free" and "albumenoid" ammonia there is a loss, which may be quite considerable, resulting from imperfect condensation of the ammonia during distillation. This loss varies in amount with the precise conditions under which the distillation is

* Some indications of a like result may be noticed in a few experiments of Tidy (*Jour. Chem. Soc.*, Lond., Jan., 1879; 80, 81) though the variation in strength of his solutions was not so great, and he himself draws the conclusion that the consumption of oxygen was proportional to the strength.

† In connection with this a number of Dr. Smart's experiments are noteworthy, in which the distillate for free ammonia furnished evidence, by its haziness and greenish colour, distinct from that which the Nessler reagent should have yielded, that volatile organic matter was present.

* In Prof. W. R. Nichols's "Report on the Boston Water Supply (Fourth Annual Report of Boston Water Board, 1880)," variations of the C : N ratio, extending from a given value to one, three, or three and a half times as great are observable for the Cochituate water within a few weeks, and still greater variations for the Mystic water.

† Examples are furnished by Frankland of analyses in which the ammonia correction is very large in comparison with the organic nitrogen.

conducted, especially with the efficiency of the cooling apparatus and the time occupied in the process.

2. In the case of waters containing urea, and also other amidated bodies, such as the leusine and tyrosine occurring among the products of putrefactive decay, some ammonia is so easily formed from these substances by boiling with sodium carbonate, or even without this addition, that it is impossible to distinguish sharply between pre-existing "free" ammonia (of ammoniacal salts) and that formed by the action of alkaline permanganate, the so-called "albumenoid" ammonia. This source of error as to the free ammonia reacts, as has been noticed above, upon the result for organic nitrogen by the combustion process.

3. There is no satisfactory evidence in favour of Wanklyn's view that, in distilling with alkaline permanganate, definite and simple fractions of the nitrogen of organic matter are given off as "albumenoid" ammonia. Such results may be varied at pleasure for most, if not for all, substances, by slight modification of the conditions under which the distillation is conducted.

4. If the distillation with alkaline permanganate be carried out as usual, in accordance with Wanklyn's instructions, it frequently happens that the nitrogenous organic matter is so gradually acted upon as to make the ending of the process indefinite; ammonia is still coming off when the distillation has to be stopped in consequence of the contents of the retort being nearly reduced to dryness. In such cases an unknown fraction of the possible amount of albumenoid ammonia fails to be collected, and is but vaguely indicated by the sign + after the figures recorded.

5. There is evidence that in some cases nitrogenous organic matter is volatilised during the distillation for free ammonia, which, if it had been retained, would have yielded up its nitrogen as albumenoid ammonia; not affecting the Nessler reagent; such nitrogenous matter escapes detection under either head.

6. The albumenoid-ammonia process proper, *i.e.*, the distillation with alkaline permanganate and determination of the ammonia evolved, is admittedly simple and easily carried out with very little preparatory training.

7. The value of the results by this process depends more upon watching the *progress* and *rate* of evolution of the ammonia than upon determining its total amount.

8. Taking the results by this process as recorded, we find a good deal of general similarity between the figures for albumenoid ammonia and those for organic nitrogen (by the combustion process), but with frequent discrepancies of varying extent, such as prevent the one being taken as the accurate measure of the other. (See Tables XIX. and XX., further on.)

Special Conclusions as to the Permanganate Process.

The chief points worthy of attention are the following:—

1. The results obtained by the Tidy method (using the acidified permanganate at common temperature) and by that of Kubel (operating at the boiling point) differ irregularly from each other, the latter usually giving much higher figures, as was to be expected, but the ratio between the results by the two methods varies much in different cases.

2. On the whole, there seems usually to be a nearer approach to proportionality with the quantities of organic carbon* found by the combustion process on the part of the results afforded by the Kubel process than on that of the Tidy results, but to this there are some very notable exceptions. (See, on this point, Tables XIX. and XX., further on.)

3. In a good many instances the results obtained by the Kubel method are, contrary to the general rule, lower than those afforded by the Tidy method. This seems to be due, in all probability, to loss of organic matter by volatilisation with the escaping steam from the boiling liquid before time has been afforded for action on the permanganate.* An examination of all the results obtained for Nos. 131, 132, and 133, and several other cases, gives good ground for believing this to be the case. Of course, a similar loss may have occurred in other instances, but not to the extent of reversing the general rule as to the results of the Kubel process being larger than those by the method of Tidy; and this may in part explain the absence of any uniform ratio between the figures yielded by those two modifications of the permanganate process.

4. The results obtainable by the Tidy process are liable to variation with the atmospheric temperature prevailing at the time the process is applied.

5. The amount of oxygen consumed by a specimen of water is probably in all ordinary cases much below that required for complete oxidation of the organic matter present, and does not stand in any fixed ratio thereto; it cannot be taken as a measure either of the organic carbon or of the total organic matter. Nevertheless, a distinct general resemblance may be traced between strongly marked results, high or low, as the case may be, for the consumption of oxygen on the one hand, and organic carbon (by the conbustion process) on the other; and closer agreement is observable in regard to waters of generally similar character.†

6. The permanganate process is capable of giving more valuable information in regard to a water by watching the *progress* and *rate* of the oxidation of organic matter present than by any single determination of the absolute amount of oxygen consumed in a given time.

7. For such observation of the progress of oxidation the two determinations prescribed by Tidy, viz., of oxygen consumed in one hour and in three hours, respectively, are not sufficient, nor is the latter period of three hours long enough to indicate the general behaviour of the water with acid permanganate.

(To be continued.)

* This appears to be the proper way of comparing the results of the permanganate with those of the combustion process. The former process is clearly concerned much more with carbon than nitrogen, if oxygen be usually at all consumed by nitrogen. It is not easy to admit the soundness of the logic with which Tidy (*Jour. Chem. Soc.*, London, January, 1879, 94-97) points to the concordance of results, by the permanganate and combustion processes, and the disagreement with both these of the results by the albumenoid-ammonia process, and hence apparently infers at the two former are trustworthy, and the last not so. He uses the *sum of organic carbon and nitrogen* to represent the results by the combustion process, and as the carbon forms generally much the larger part of this, he naturally arrives at an agreement with the results of the process mainly depending on the oxidation of carbon, and disagreement with those of the process evolving nitrogen as ammonia.

* It is worthy of remark that the largest number of cases among natural waters of the Kubel process giving a lower result than that by the Tidy process occur among the waters believed to be *dangerous*; *i.e.*, Class II.

† In accordance with the remarks of Frankland: "Water Analysis," p. 55.

NOTICES OF BOOKS.

Irenicon, No. 2. Faith, the Life-root of Science, Philosophy, Ethics, and Religion. By H. Griffith, F.G.S. London: Elliot Stock.

Much of the work before us does not fall within the legitimate purview of the Chemical News. Still we find here no little matter which the physicist and chemist not only may, but should, consider, and to which we accordingly feel free to draw attention. Mr. Griffith's fundamental idea appears plainly in the title he has selected, and will by many be regarded as startling, if not absolutely paradoxical. The life-root of Science, say and think many, is by no means faith, but sight, or rather the direct evidence of our senses in general. We believe, say they, what we see and nothing further. They may

perhaps, however, if they follow the author be led greatly to modify this opinion.

In two introductory chapters, or lectures, Mr. Griffith gives a condensed sketch of the development of human thought from the days of earliest tradition down to this noisy nineteenth century of ours. The facts herein brought forward are of course not novel, but the author often puts them in a peculiar, instructive light: he quotes writers little—may we say insufficiently—known, and throws out suggestive reflections. In reference to the past he does not endorse the common self-complacent theory which holds that whilst we have learnt much we have forgotten nothing. Picturing a well-equipped steamer wrecked on some savage coast, he says:—"However eloquently its flotsam and jetsam might tell of the possibilities of high civilisation, it would be in language admitting of no translation intelligible to the poor natives. Condensers, compasses, chronometers, aneroids, &c., represent clusters of ideas the most gifted barbarian cannot be expected to understand. Is it certain that the Past never had any inventions quite as far beyond our reach?" In a note he adds—"I know not what theory the reader may hold in respect to the Cyclopean statues and terraces, &c., which have given such world-wide fame to Easter Island. No explanation I have ever yet seen meets half the real difficulties of the case." His estimate of the Middle Ages is not flattering. "Now and again," says he, "Christendom could send out bullies to fight in Palestine, or qualify inquisitors to search for and burn heretics nearer home, but for genuine culture she had no taste, and for progress no feeling save that of horror."

A survey of the Baconian movement leads the author to the principle—or, as he calls it, the very soul—of Science, that whereby it is differentiated from mere floating opinion, *i.e.*, strict verification." This principle of strict and humble submission to facts he traces as equally essential in Science and in Morals. Whilst recognising the freedom of will, he declares that "none the less has it necessities and sequences of its own, essentially incompatible with the notion of chaos." "If the increment of crystals is subject to specific regulations, so is the growth of vegetables and animals, and we need not scruple to add, so also is the growth of mind and character, each in its own order." "Be their spheres of action ever so widely apart, and there factors ever so incommensurable, it is utterly impossible to believe that a good man is a whit less *orderly* a production than a good watch or a good steam-engine." Chance as a maker or manipulator of anything he utterly discards, admitting of course that Nature has mysteries innumerable. "Of practical solecisms or absolute lawlessness Science has never been able to detect a vestige." Time, he considers, has problems of its own still more difficult than those of space, and there are other cases where the antecedent and consequent seem to run on such different planes that we have no common data for determining their mutual relation. Among the difficulties which scientific men encounter he enumerates isomerism and catalysis. As regards the former we must remark that a diverse arrangement of molecules, once suggested as a tentative hypothesis to explain why bodies alike in percentage composition should possess such different properties, is now established on fairly tenable ground. At least by working on this supposition the organic chemist arrives at correct results. Catalysis, instead of being explained, is being set aside as an unnecessary hypothesis.

In the third chapter the author comes to the "Principles and Method of Induction." Whilst accepting this method "ungrudgingly, and even with heartiest thankfulness," he holds—and very justly—that there is room for caution as to the manner in which we apply it. Here he is lead to an appreciation of Positivism, Comtism, or as it is now sometimes called, Cosmism. From a variety of familiar instances he shows that the utmost caution is needed in arguing from the few instances observed to the many, or all, possibly existing cases. He asks what is the immediate, exact evidence on which we rely in asserting that the consequences of falling from the top of the Monument, or of swallowing a strong dose of prussic acid, would be mortal? *Experience*, he contends, can only cover the past, or rather only that part of it with which the observer has been personally brought into contact, but "as applied to the future it is a word without meaning, unless we keep in the background some such postulate as this, that whatsoever has been will, under like circumstance, be repeated. But in making this postulate we are "walking by faith, not by sight."

It is impossible to confine thought within the narrow sphere of Positivism. The mere registering of phenomena, however important, is but a small part of the interpretation of Nature. As Professor Huxley observes—"The term 'positive' as implying a system of thought which assumes nothing beyond the content of observed facts implies that which never did exist and never will." We shall be the more inclined to reject Comte as a guide if we remember that he upheld the principle of exclusively binary combination in chemistry, just as it was about to be discarded by chemists; that he declared himself for the individual origin of organic forms just on the eve of the avatar of Evolutionism; that he and his followers speak but contemptously of pure research, and that they are perfectly willing to place difficulties in its way.

Warned that we have already nearly exhausted our space, we are compelled to overlook many suggestive, and in some respects humiliating, instances of what, in our scientific researches, we are obliged to take upon trust, or upon the testimony of others. It is even to the mightiest minds wholesome to be reminded of such truths.

We must recommend "Faith" to the serious attention at once of students and of masters in science. Whether they can accept all its teachings or not, it will assuredly purify their intellectual atmosphere.

Water Works Statistics, 1882; Second Issue. *Gas Works Statistics*, 1882; Fourth Issue. *The Gas and Water Companies Directory*, 1882; Sixth Issue. Edited by Charles W. Hastings. London: The Scientific Publishing Company.

These three manuals will be of great use to all persons connected with municipal affairs or interested in sanitary movements. As far as we have been able to test the information given it is exceedingly correct, though in many cases the author has not been able to obtain particulars of the water or gas works. We find no mention of the Aylesbury Water Works (Chiltern Hills) at all. We are glad to see that the principle of a constant supply is now adopted in a great majority of towns and districts.

OBITUARY.

PROF. W. STANLEY JEVONS, F.R.S.

We are inexpressibly shocked and distressed at learning the untimely death of Professor W. Stanley Jevons, F.R.S., who was drowned on Monday last whilst bathing in the sea near the village of Bexhill, in Sussex.

B. J. GROSJEAN, F.C.S., &c.

We regret having to record the death of Mr. J. J. Beaumont Jeanneret Grosjean, F.C.S., F.I.C., an occasional contributor to the Chemical News. The deceased gentleman, who was only in his fortieth year, held the position of Chemist at the Manure Works of Messrs. J. B. Lawes and Co., and was justly regarded as an authority concerning the applications of chemistry to agriculture. We understand that his papers have been placed in the hands of Mr. Warington for publication.

CORRESPONDENCE.

DETERMINATION OF ARSENIC IN COPPER.

To the Editor of the Chemical News.

SIR,—As Dr. Watson's note in the CHEMICAL NEWS (vol. xlvi., p. 46) makes a charge of dishonesty against me, I feel sure that you will allow me space for a reply.

With regard to the use of iron as a means of separating arsenic, I of course make no claim whatever to that. It has long been known that ferric hydrate precipitated by ammonia carries down the arsenic; indeed, I believe it is given by Fresenius as a general method of separating arsenic from the metals not precipitated by ammonia.

The only point I do claim is the substitution of sodium acetate for ammonia, and I feel quite certain that not only was this change not suggested or even hinted to me by Dr. Watson, but that it was on my suggestion that it was introduced into the laboratory. The after operations are practically identical with Abel and Field's method.

Since any value there may be in my note will be in the matter and not in the author, and since petty disputes as to priority can be of no interest to your readers, I much regret being compelled to thus occupy your valuable space.—I am, &c.,

A. HUMBOLDT SEXTON.

Burslem, August 14, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 4, July 24, 1882.

New Researches on the Propagation of Explosive Phenomona in Gases.—The speed of translation of the gaseous molecules preserving the totality of the *vis viva* which corresponds to the heat liberated by the reaction, may be regarded as a limit representing the maximum speed of propagation of the explosive wave. But this speed is diminished by contact with gases and other foreign bodies, and equally so when the mass ignited is too small, and is too rapidly cooled by radiation, and also when the elementary speed of the chemical reaction is too feeble, as may happen with carbonic oxide. In these conditions there is a retardation of the wave, and it may even cease to reproduce itself, the combustion then propagating itself according to a much slower law.

Separation of Gallium.—Lecoq de Boisbaudran.—See p. 69.

Chemical Work Produced by the Battery.—D. Tommasi.—It results from the author's experiments that a chromic acid element, as employed by Favre, that is to say, having a positive electrode of platinum, produces an external chemical work only equal to about 65 cals. If in the same element we substitute for platinum, carbon or platinum sponge, about 85 cals. may be rendered transmissible to the circuit, or 20 cals. more than in the former element.

Variation of Friction Produced by Voltaic Polarisation.—M. Krouchkoll.—The attention of physicists has been called to a new fact, the variation in the friction of a metallic surface against an electrolyte when a current is passed between the two bodies. According to M. Koch (*Wiedemann's Annalen*, 1879, p. 92), polarisation by means of oxygen affects the rubbing surface of palladium or platinum so as to increase the friction, whilst polarisation by means of hydrogen produces no effect. The author finds that polarisation by means of oxygen increases the friction, whilst polarisation with hydrogen diminishes it.

Amplitude of Telephonic Vibrations.—G. Salet.—The amplitude of the vibrations of the receiving plate is from 2 to 3 ten-thousandths of a millimetre.

Use of Crushing-Manometers for the Measurement of the Pressures Developed by Explosives.—MM. Sarrau and Vieille.—This paper does not admit of useful abstraction.

Reproduction of Calcite and Witherite.—MM. Miron and Bruneau.—The authors have obtained calcite by aspirating air charged with ammoniacal gas through river water. Witherite was produced by using distilled water charged with barium carbonate held in solution by means of carbonic acid.

Evaporation of Metals in a Vacuum.—E. Demarçay.—All the metals which the author has examined have given signs of volatilisation at temperatures relatively very low. The author is continuing his researches, and hopes to lay before the Academy proofs of the volatilisation of metals of the iron and platinum groups at temperatures much lower than are generally supposed.

Determination of Astringent Matters in Wines.—Aimé Girard.—The author considers that none of the known methods are trustworthy when the proportion of astringent matter to be determined is small. He uses as a reagent the bowels of sheep, such as are used for fiddle-strings; not in the state in which they are met with in commerce, but before they have undergone the final polishing in oil. White strings of the best quality should be taken. The author operates upon 100 c.c. of wine, diluting it with water if it contains much organic matter. Four or five strings are taken, and a known portion, 1 grm., is cut off for the determination of water. A quantity of the same strings is taken, from 3 to 5 grms., according to the quality of the wine. The weighed portion is put to steep in water for four or five hours, until the cords swell, and can be easily untwisted by hand. They are then put into the wine to be analysed. After about twenty-four to forty-eight hours, the wine has entirely lost its colour, and the addition of ferric chloride no longer produces any reaction. The strings are then washed twice or thrice with distilled water, and dried at first at 35° to 40° in a flat vessel. When they are no longer adhesive they are placed in a bottle, which can be easily stoppered, and the drying is finished at a temperature which must not exceed 100° to 102°. The increase of weight, due allowance having been made for the moisture originally present, shows the proportion of œno-tannin and colouring-matter contained in the wine.

The Law of the Congelation of the Solutions of Neutral Substances in Benzol.—F. M. Raoult.—The acetons, aldehyds, ethers, hydrocarbides, and their derivatives, dissolved in one and the same quantity of benzol in proportion to their molecular weights, all lower the point of congelation of this liquid by about the same number of degrees. In a multitude of cases the lowering of the congelation-point of a solvent depends merely on the relation between the numbers of the molecules of the dissolved body and of the solvent; it is independent of the nature, the number, and the arrangement of the atoms which compose the dissolved molecules.

Bulletin de la Société Chimique de Paris. June 5, 1882.

Chromium Phosphate and its Utilisation in Analysis and in the Arts.—A. Carnot.—Already noticed.

Researches on Glycolic Ether and on the Ethylene Oxides.—M. Berthelot.—A thermo-chemical paper which has been already noticed.

Hydrochloric Ether of Glycol.—M. Berthelot.—Already noticed.

Russian Chemical Society.—Session May 7th to 19th, 1881.—M. A. Krakau.

M. Beketoff sent in a preliminary notice on potassium protoxide. He finds that metallic potassium is without action upon potassium hydrate.

M. Barsilowsky doubts the existence of the two compounds obtained by Mr. Perkin on oxidising para-toluidine.

M. Menchoutkine affirms that the study of the formation of the compound ethers may contribute to the solution of various questions relative to the chemical structure of these bodies.

M. Wilm announces researches on the metals of the platinum group.

M. Pawlinoff announces that on agitating aniline with methyl-iodide and an excess of potassium hydroxide in an aqueous solution, there is development of heat and production of $C_6H_5(CH_3)_3NI$.

M. Almedingen on agitating crotonylene with sulphuric acid at common temperatures, obtains hexa-methyl-benzol, a white crystalline substance, melting at 163°.

M. Lwoff adds that the crotonylene studied by M. Almedingen was prepared two years ago by Mlle. Lermontoff.

M. Kutcheroff pointed out a new method of hydrating the hydrocarbons of the acetylenic series by means of mercury bromide.

The *Journal of the Russian Chemical Society*, vol. xiii., part 6, contains the following memoirs:—On anhydrous potassium oxide, M. Beketoff; Action of zinc-methyl upon the mono-, di-, and tri-acetyl chlorides, M. Bogomoletz; On the laws of double decomposition, M. Potilitzine; On the terebene derivative of diamylene, M. Tougolessoff; On the preparation of tri-methyl-phenyl-ammonium, M. Pawlinoff; On the azo-derivatives of toluene, M. Barsilowsky.

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Justus Liebig's Annalen der Chemie,
Band 212, Heft 3.

Chemical Theory of Gunpowder.—H. Debus.—The first part of a memoir read before the Royal Society.

Hydrazine Compounds.—Emil Fischer.—In this third section the author examines, first, the sulphureas of phenyl-hydrazine, in particular diphenyl-sulpho-carbazone, its oxidation, its reduction; phenyl-sulpho-semi-carbazide, phenyl-sulpho-carbizine, with its salts and derivatives; secondly, the hydrazin-benzoic acids, ortho-hydrazin-benzoic anhydride, para-hydrazin-benzoic acid; and thirdly, ortho-tolyl-hydrazine.

Compounds of Phthalic Acid with the Phenols.—Adolf Baeyer.—In this fourth section of the memoir we find an account of para-cresol-phthalein-anhydride, of the anhydride of para-cresol-naphthaline, the scission-products of phthaleine anhydride on fusion with potassa, and the condensation-products obtained by the action of concentrated sulphuric acid. In a second part the author discusses phenol-phthaleine anhydride and the constitution of fluoresceine.

Band 213, Heft 1.

Chemical Composition of the Minerals of the Cryolite Group.—Josef Brandl.—These researches comprehend analyses of the minerals cryolite, pachnolite, Thomsenolite, Ralstonite, and chiolite, as well as of prosopite and fluellite.

Chemical Theory of Gunpowder.—H. Debus.—A continuation.

The Crystalline Water of Calcium Butyrate and its Curve of Solubility.—Otto Hecht.—The calcium salt obtained in crystals from solutions between 6° and 80° contain one molecule of water, which they lose slowly at 100°, but readily at 110°. Calcium butyrate becomes less soluble at higher temperatures, but, unlike other salts possessing this property, the crystals formed at high temperatures contain the same quantity of water as those formed at lower temperatures.

Molecular Refraction of Liquid Organic Compounds.—H. Landolt.—Not capable of useful abstraction.

Communications from the Chemical Laboratory of the University of Graz.—These consist of a paper by L. Pebal and G. Schacherl on the vapour-density of hypochloric acid, and a memoir by Julius Domac on the action of hypochloric acid upon hexylene.

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Moniteur Scientifique, Quesneville.
July, 1882.

Contribution to the Study of the Cerite Metals.—Dr. Bohuslav Brauner.—We shall endeavour to give in full the most important parts of this long and valuable memoir.

Patents taken Abroad.—A list of specifications of chemical patents, chiefly German.

Condensation-Products of the Fatty Acids.—H. de Pechmann.—A translation from the *Berichte der Deutsch. Chem. Gesellschaft.*

Studies on Caffeine and Theo-bromine.—MM. Maly, Hinteregger, and Andreasch.—In this memoir the authors consider the action of bromine and water upon caffeine, and the formation of dimethyl-alloxane, apocaffeine, and cafuric and dimethyl-dialuric acids.

Condensation-Products of the Aromatic Bases.—O. Fischer.

Derivatives of Quinoleine.—Z. H. Skraup.

Transformation of α- and β-Naphthol into Naphthylamines.—A. Calm.

Anthramine.—MM. Liebermann and Bollert.

Halogenous Derivatives of Quinoleine.—W. al Coste.

Colouring-Matters derived from Resorcine.—G. Damm and L. Schreiner.

Preparation of Azo-oxy-benzol.—H. Klinger.

Compounds of the Indigotic Group.—A. Baeyer.—These eight papers are abstracts from the *Berlin Berichte.*

Certain Practical Considerations on Recent Researches on Nitrification.—R. Warington.—A translation of a paper read before the Society of Arts.

Contribution to the Study of Antiseptics.—Fr. Boillat.—From the *Journal für Praktische Chemie.*

Detection of Sugar in the Urine: Principal Causes of Error.—A. Robin.—If the patient has absorbed terebenthenoid compounds there is found in the urine an unknown body which some chemists approximate to formic acid, but which reduces Fehling's liquid, as does sugar, and even bismuth subnitrate heated with caustic potassa. The urine of persons who have taken chloral or chloroform:—In urines loaded with urates and uric acid Fehling's liquid turns green and yellow, becomes turbid, and especially if the liquid is kept long at a boil a precipitate is deposited quite similar to that of cuprous oxide reduced by diabetic sugar. The reactions may, however, be thus distinguished: The reduction effected by sugars produces a precipitate which is from the beginning pulverulent, and is of a bright red or yellow, and afterwards takes a brownish or blackish colour, but has no resemblance to the whitish, flocculent precipitate, which appears in a urine charged with urates. The distinction is most easy at the outset of the reaction. When Fehling's liquid is rendered turbid by urates there appear in it isolated clouds, between which the liquid remains limpid. With caustic potassa the causes of error are less numerous. However, if a urine contains blood, the colouring-matter of the blood if heated with potassa may darken almost to blackness, but it is still a reddish or purple-brown, differing in tint from that given by diabetic sugar.

THE CHEMICAL NEWS.

Vol. XLVI. No. 1187.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Southampton Meeting, August 23, 1882.

INAUGURAL ADDRESS OF THE PRESIDENT,

C. William Siemens, D.C.L. (Oxon), LL.D. (Glasgow and Dublin), Ph.D., F.R.S., F.C.S., Member Inst. C.E.

In venturing to address the British Association from this chair, I feel that I have taken upon myself a task involving very serious responsibility. The Association has for half a century fulfilled the important mission of drawing together, once every year, scientists from all parts of the country for the purpose of discussing questions of mutual interest, and of cultivating those personal relations which aid so powerfully in harmonising views, and in stimulating concerted action for the advancement of science.

A sad event casts a shadow over our gathering. While still mourning the irreparable loss Science has sustained in the person of Charles Darwin, whose bold conceptions, patient labour, and genial mind made him almost a type of unsurpassed excellence, telegraphic news reached Cambridge, just a month ago, to the effect that our Honorary Secretary, Professor F. M. Balfour, had lost his life during an attempted ascent of the Aiguille Blanche de Penteret. Although only thirty years of age, few men have won distinction so rapidly and so deservedly. After attending the lectures of Michael Foster, he completed his studies of biology under Dr. Anton Dohrn at the Zoological Station of Naples, in 1875. In 1878 he was elected a Fellow, and in November last a member of Council of the Royal Society, when he was also awarded one of the Royal Medals for his embryological researches. Within a short interval of time Glasgow University conferred on him their honorary degree of LL.D., he was elected President of the Cambridge Philosophical Society, and after having declined very tempting offers from the Universities of Oxford and Edinburgh, he accepted a professorship of Animal Morphology created for him by his own University. Few men could have borne without hurt such a stream of honourable distinctions, but in young Balfour genius and independence of thought were happily blended with industry and personal modesty; these won for him the friendship, esteem, and admiration of all who knew him.

Since the days of the first meeting of the Association in York, in 1831, great changes have taken place in the means at our disposal for exchanging views, either personally or through the medium of type. The creation of the railway system has enabled congenial minds to attend frequent meetings of those special Societies which have sprung into existence since the foundation of the British Association, amongst which I need only name here the Physical, Geographical, Meteorological, Anthropological, and Linnean, cultivating abstract science, and the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, the Society of Telegraph Engineers and Electricians, the Gas Institute, the Sanitary Institute, and the Society of Chemical Industry, representing applied science. These meet at frequent intervals in London, whilst others, having similar objects in view, hold their meetings at the University towns, and at other centres of intelligence and industry throughout the country, giving evidence of great mental activity, and producing some of those very results which the founders of the British Association wished to see realised. If we consider, further, the extraordinary development of scientific journalism which has taken place, it cannot surprise us when we meet with expressions of opinion to the effect that the British Association has fulfilled its mission, and should now yield its place to those special Societies it has served to call into existence. On the other hand, it may be urged that the brilliant success of last year's Anniversary Meeting, enhanced by the comprehensive address delivered on that occasion by my distinguished predecessor in office, Sir John Lubbock, has proved, at least, that the British Association is not dead in the affections of its members, and it behoves us at this, the first ordinary gathering in the second half-century, to consider what are the strong points to rely upon for the continuance of a career of success and usefulness.

If the facilities brought home to our doors of acquiring scientific information have increased, the necessities for scientific enquiry have increased in a greater ratio. The time was when science was cultivated only by the few, who looked upon its application to the arts and manufactures as almost beneath their consideration; this they were content to leave in the hands of others, who, with only commercial aims in view, did not aspire to further the objects of science for its own sake, but thought only of benefiting by its teachings. Progress could not be rapid under this condition of things, because the man of pure science rarely pursued his enquiry beyond the mere enunciation of a physical or chemical principle, whilst the simple practitioner was at a loss how to harmonise the new knowledge with the stock of information which formed his mental capital in trade.

The advancement of the last fifty years has, I venture to submit, rendered theory and practice so interdependent that an intimate union between them is a matter of absolute necessity for our future progress. Take, for instance, the art of dyeing, and we find that the discovery of new colouring-matters derived from waste-products, such as coal-tar, completely changes its practice, and renders an intimate knowledge of the science of chemistry a matter of absolute necessity to the practitioner. In telegraphy and in the new arts of applying electricity to lighting, to the transmission of power, and to metallurgical operations, problems arise at every turn, requiring for their solution not only an intimate acquaintance with, but a positive advance upon, electrical science, as established by purely theoretical research in the laboratory. In general engineering the mere practical art of constructing a machine so designed and proportioned as to produce mechanically the desired effect, would suffice no longer. Our increased knowledge of the nature of the mutual relations between the different forms of energy makes us see clearly what are the theoretical limits of effect; these, although beyond our absolute reach, may be looked upon as the asymptotes to be approached indefinitely by the hyperbolic course of practical progress, of which we should never lose sight. Cases arise, moreover, where the introduction of new materials of construction, or the call for new effects, renders former rules wholly insufficient. In all these cases practical knowledge has to go hand in hand with advanced science in order to accomplish the desired end.

Far be it from me to think lightly of the ardent students of nature, who, in their devotion to research, do not allow their minds to travel into the regions of utilitarianism and of self-interest. These, the high priests of science, command our utmost admiration; but it is not to them that we can look for our current progress in practical science, much less can we look for it to the "rule of

thumb" practitioner, who is guided by what comes nearer to instinct than to reason. It is to the man of science, who also gives attention to practical questions, and to the practitioner, who devotes part of his time to the prosecution of strictly scientific investigations, that we owe the rapid progress of the present day, both merging more and more into one class, that of pioneers in the domain of nature. It is such men that Archimedes must have desired when he refused to teach his disciples the art of constructing his powerful ballistic engines, exhorting them to give their attention to the principles involved in their construction, and that Telford, the founder of the Institution of Civil Engineers, must have had in his mind's eye, when he defined civil engineering as "the art of directing the great sources of power in nature."

These considerations may serve to show that although we see the men of both abstract and applied science group themselves in minor bodies for the better prosecution of special objects, the points of contact between the different branches of knowledge are ever multiplying, all tending to form part of a mighty tree—the tree of modern science under whose ample shadow its cultivators will find it both profitable and pleasant to meet, at least once a year; and considering that this tree is not the growth of one country only, but spreads both its roots and branches far and wide, it appears desirable that at these yearly gatherings other nations should be more fully represented than has hitherto been the case. The subjects discussed at our meetings are without exception of general interest, but many of them bear an international character, such as the systematic collection of magnetic, astronomical, meteorological, and geodetical observations, the formation of a universal code for signalling at sea, and for distinguishing lighthouses, and especially the settlement of scientific nomenclatures and units of measurement, regarding all of which an international accord is a matter of the utmost practical importance.

As regards the measures of length and weight it is to be regretted that this country still stands aloof from the movement initiated in France towards the close of last century; but, considering that in scientific work metrical measure is now almost universally adopted, and that its use has been already legalised in this country, I venture to hope that its universal adoption for commercial purposes will soon follow as a matter of course. The practical advantages of such a measure to the trade of this country would, I am convinced, be very great, for English goods, such as machinery or metal rolled to current sections, are now almost excluded from the Continental market, owing to the unit measure employed in their production. The principal impediment to the adoption of the metre consists in the strange anomaly that although it is legal to use that measure in commerce, and although a copy of the standard metre is kept in the Standards' Department of the Board of Trade, it is impossible to procure legalised rods representing it, and to use a non-legalised copy of a standard in commerce is deemed fraudulent. Would it not be desirable that the British Association should endeavour to bring about the use in this country of the metre and kilogramme, and, as a preliminary step, petition the Government to be represented on the International Metrical Commission, whose admirable establishment at Sèvres possesses, independently of its practical work, considerable scientific interest, as a well-found laboratory for developing methods of precise measurement?

Next in importance to accurate measures of length, weight, and time, stand, for the purposes of modern science, those of electricity.

The remarkably clear lines separating conductors from non-conductors of electricity, and magnetic from non-magnetic substances, enable us to measure electrical quantities and effects with almost mathematical precision; and, although the ultimate nature of this, the youngest scientifically investigated form of energy, is yet wrapt in mystery, its laws are the most clearly established, and its measuring instruments (galvanometers, electrometers, and magnetometers), are amongst the most accurate in physical science. Nor could any branch of science or industry be named in which electrical phenomena do not occur, to exercise their direct and important influence.

If, then, electricity stands foremost amongst the exact sciences, it follows that its unit measures should be determined with the utmost accuracy. Yet, twenty years ago, very little advance had been made towards the adoption of a rational system. Ohm had, it is true, given us the fixed relations existing between electromotive force, resistance, and quantity of current; Joule had established the dynamical equivalent of heat and electricity, and Gauss and Weber had proposed their elaborate system of absolute magnetic measurement. But these invaluable researches appeared only as isolated efforts, when, in 1862, the Electric Unit Committee was appointed by the British Association, at the instance of Sir William Thomson, and it is to the long-continued activity of this Committee that the world is indebted for a consistent and practical system of measurement, which, after being modified in details, received universal sanction last year by the International Electrical Congress assembled at Paris.

At this Congress, which was attended officially by the leading physicists of all civilised countries, the attempt was successfully made to bring about a union between the statical system of measurement that had been followed in Germany and some other countries, and the magnetic or dynamical system developed by the British Association, also between the geometrical measure of resistance, the (Werner) Siemens unit, that had been generally adopted abroad, and the British Association unit intended as a multiple of Weber's absolute unit, though not entirely fulfilling that condition. The Congress, while adopting the absolute system of the British Association, referred the final determination of the unit measure of resistance to an International Committee, to be appointed by the representatives of the several governments; they decided to retain the mercury standard for reproduction and comparison, by which means the advantages of both systems are happily combined, and much valuable labour is utilised; only, instead of expressing electrical quantities directly in absolute measure, the Congress has embodied a consistent system, based on the Ohm, in which the units are of a value convenient for practical measurements. In this, which we must hereafter know as the "practical system," as distinguished from the "absolute system," the units are named after leading physicists, the Ohm, Ampère, Volt, Coulomb, and Farad.

I would venture to suggest that two further units might, with advantage, be added to the system decided on by the International Congress at Paris. The first of these is the unit of magnetic quantity or pole. It is of much importance, and few will regard otherwise than with satisfaction the suggestion of Clausius that the unit should be called a "Weber," thus retaining a name most closely connected with electrical measurements, and only omitted by the Congress in order to order to avoid the risk of confusion in the magnitude of the unit current with which his name had been formerly associated.

The other unit I should suggest adding to the list is that of power. The power conveyed by a current of an Ampère through the difference of potential of a Volt is the unit consistent with the practical system. It might be appropriately called a Watt, in honour of that master mind in mechanical science, James Watt. He it was who first had a clear physical conception of power, and gave a rational method of measuring it. A Watt, then, expresses the rate of an Ampère multiplied by a Volt, whilst a horse-power is 746 Watts, and a Cheval de Vapeur 735.

The system of electro-magnetic units would then be:—

		C.G.S. Units.
(1)	Weber, the unit of magnetic quantity	$=10^8$
(2)	Ohm, ,, ,, resistance	$=10^9$
(3)	Volt, ,, ,, electromotive force	$=10^8$
(4)	Ampère ,, ,, current	$=10^{-1}$
(5)	Coulomb ,, ,, quantity	$=10^{-1}$
(6)	Watt ,, ,, power	$=10^7$
(7)	Farad ,, ,, capacity	$=10^{-9}$

The word Energy was first used by Young in a scientific sense, and represents a conception of recent date, being the outcome of the labours of Carnot, Mayer, Joule, Grove, Clausius, Clerk-Maxwell, Thomson, Stokes, Helmholtz, Macquorn-Rankine, and other labourers, who have accomplished for the science regarding the forces in Nature what we owe to Lavoisier, Dalton, Berzelius, Liebig, and others, as regards Chemistry. In this short word Energy we find all the efforts in nature, including electricity, heat, light, chemical action, and dynamics, equally represented, forming, to use Dr. Tyndall's apt expression, so many "modes of motion." It will readily be conceived that when we have established a fixed numerical relation between these different modes of motion, we know beforehand what is the utmost result we can possibly attain in converting one form of energy into another, and to what extent our apparatus for effecting the conversion falls short of realising it. The difference between ultimate theoretical effect and that actually obtained is commonly called loss, but, considering that energy is indestructible, represents really secondary effect which we obtain without desiring it. Thus friction in the working parts of a machine represents a loss of mechanical effect, but is a gain of heat, and in like manner the loss sustained in transferring electrical energy from one point to another is accounted for by heat generated in the conductor. It sometimes suits our purpose to augment the transformation of electrical into heat energy at certain points of the circuit when the heat rays become visible, and we have the incandescence electric light. In effecting a complete severance of the conductor for a short distance, after the current has been established, a very great local resistance is occasioned, giving rise to the electric arc, the highest development of heat ever attained. Vibration is another form of lost energy in mechanism, but who would call it a loss if it proceeded from the violin of a Joachim or a Norman-Neruda?

Electricity is the form of energy best suited for transmitting an effect from one place to another; the electric current passes through certain substances—the metals—with a velocity limited only by the retarding influence caused by electric charge of the surrounding dielectric, but approaching probably under favourable conditions that of radiant heat and light, or 300,000 kilometres per second; it refuses, however, to pass through oxidised substances, glass, gums, or through gases except when in a highly rarefied condition. It is easy therefore to confine the electric current within bounds, and to direct it through narrow channels of extraordinary length. The conducting wire of an Atlantic cable is such a narrow channel; it consists of a copper wire, or strand of wires, 5 m.m. in diameter, by nearly 5000 kilometres in length, confined electrically by a coating of guttapercha about 4 m.m. in thickness. The electricity from a small galvanic battery passing into this channel prefers the long journey to America in the good conductor, and back through the earth, to the shorter journey across the 4 m.m. in thickness of insulating material. By an improved arrangement the alternating currents employed to work long submarine cables do not actually complete the circuit, bnt are merged in a condenser at the receiving station after having produced their extremely slight but certain effect upon the receiving instrument. So perfect is the channel and so precise the action of both the transmitting and receiving instruments employed, that two systems of electric signals may be passed simultaneously through the same cable in opposite directions, producing independent records at either end. By the application of this duplex mode of working to the Direct United States cable under the superintendence of Dr. Muirhead, its transmitting power was increased from twenty-five to sixty words a minute, being equivalent to about twelve currents or primary impulses per second.

The minute currents here employed are far surpassed as regards delicacy and frequency by those revealed to us by that marvel of the present day, the telephone. The electric currents caused by the vibrations of a diaphragm acted upon by the human voice, naturally vary in frequency and intensity according to the number and degree of those vibrations, and each motor current in exciting the electro-magnet forming part of the receiving instrument, deflects the iron diaphragm occupying the position of an armature to a greater or smaller extent according to its strength. Savart found that the fundamental *la* springs from 440 complete vibrations in a second, but what must be the frequency and modulations of the motor current and of magnetic variations necessary to convey to the ear through the medium of a vibrating armature, such a complex of human voices and of musical instruments as constitutes an opera performance. And yet such performances could be distinctly heard and even enjoyed as an artistic treat by applying to the ears a pair of the double telephonic receivers at the Paris Electrical Exhibition, when connected with a pair of transmitting instruments in front of the footlights of the Grand Opera. In connection with the telephone, and with its equally remarkable adjunct, the microphone, the names of Riess, Graham Bell, Edison, and Hughes will ever be remembered.

Regarding the transmission of power to a distance the electric current has now entered the lists in competition with compressed air, the hydraulic accumulator, and the quick running rope as used at Schaffhausen to utilise the power of the Rhine fall. The transformation of electrical into mechanical energy can be accomplished with no further loss than is due to such incidental causes as friction and the heating of wires; these in a properly designed dynamo-electric machine do not exceed 10 per cent, as shown by Dr. John Hopkinson, and, judging from recent experiments of my own, a still nearer approach to ultimate perfection is attainable. Adhering, however, to Dr. Hopkinson's determination for safety's sake, and assuming the same percentage in re-converting the current into mechanical effect, a total loss of 19 per cent results. To this loss must be added that through electrical resistance in the connecting line wires, which depends upon their length and conductivity, and that due to heating by friction of the working parts of the machine. Taking these as being equal to the internal losses incurred in the double process of conversion, there remains a useful effect of $100-38=62$ per cent, attainable at a distance, which agrees with experimental results, although in actual practice it would not be safe at present to expect more than 50 per cent of ultimate useful effect, to allow for all mechanical losses.

In using compressed air or water for the transmission of power the loss cannot be taken at less than 50 per cent, and as it depends upon fluid resistance it increases with distance more rapidly than in the case of electricity. Taking the loss of effect in all cases at 50 per cent, electric transmission presents the advantage that an insulated wire does the work of a pipe capable of withstanding high internal pressure, which latter must be more costly to put down and to maintain. A second metallic conductor is required, however, to complete the electrical circuit, as the conducting power of the earth alone is found unreliable for passing quantity currents, owing to the effects of polarisation; but as this second conductor need not be insulated, water or gas pipes, railway metals or fencing wire, may be called into requisition for the purpose. The small space occupied by the electro-motor, its high working speed, and the absence of waste products, render it specially available for the general distribution of power to cranes and light machinery of every description. A

loss of effect of 50 per cent. does not stand in the way of such applications, for it must be remembered that a powerful central engine of best construction produces motive power with a consumption of two pounds of coal per horse-power per hour, whereas small engines distributed over a district would consume not less than five; we thus see that there is an advantage in favour of electric transmission as regards fuel, independently of the saving of labour and other collateral benefits.

To agriculture, electric transmission of power seems well adapted for effecting the various operations of the farm and the fields from one centre. Having worked such a system myself in combination with electric lighting and horticulture for upwards of two years, I can speak with confidence of its economy, and of the facility with which the work is accomplished in charge of untrained persons.

As regards the effect of the electric light upon vegetation there is little to add to what was stated in my paper read before Section A last year, and ordered to be printed with the Report, except that in experimenting upon wheat, barley, oats, and other cereals sown in the open air, there was a marked difference between the growth of the plants influenced and uninfluenced by the electric light. This was not very apparent till towards the end of February, when, with the first appearance of mild weather, the plants under the influence of an electric lamp of 4000 candle-power placed about 5 metres above the surface, developed with extreme rapidity, so that by the end of May they stood above 4 feet high, with the ears in full bloom, when those not under its influence were under 2 feet in height, and showed no sign of the ear.

In the electric railway first constructed by Dr. Werner Siemens, at Berlin, in 1879, electric energy was transmitted to the moving carriage or train of carriages through the two rails upon which it moved, these being sufficiently insulated from each other by being placed upon well creosoted cross sleepers. At the Paris Electrical Exhibition the current was conveyed through two separate conductors making sliding or rolling contact with the carriage, whereas in the electric railway now in course of construction in the north of Ireland (which, when completed, will have a length of twelve miles), a separate conductor will be provided by the side of the railway, and the return circuit completed through the rails themselves, which in that case need not be insulated; secondary batteries will be used to store the surplus energy created in running downhill, to be restored in ascending steep inclines, and for passing roadways where the separate insulated conductor is not practicable. The electric railway possesses great advantages over horse or steam-power for towns, in tunnels, and in all cases where natural sources of energy, such as waterfalls, are available; but it would not be reasonable to suppose that it will in its present condition compete with steam propulsion upon ordinary railways.

The deposition of metals from their solutions is perhaps the oldest of all useful applications of the electric current, but it is only in very recent times that the dynamo current has been practically applied to the refining of copper and other metals, as now practised at Birmingham and elsewhere, and upon an exceptionally large scale at Ocker, in Germany. The dynamo machine there employed was exhibited at the Paris Electrical Exhibition, its peculiar feature being that the conductors upon the rotating armature consisted of solid bars of copper 30 m.m. square, in section, which were found only just sufficient to transmit the large quantity of electricity of low tension necessary for this operation. One such machine consuming 4-horse power deposits about 300 kilogrammes of copper per 24 hours; the motive power at Ocker is derived from a waterfall.

Electric energy may also be employed for heating purposes, but in this case it would obviously be impossible for it to compete in point of economy with the direct combustion of fuel for the attainment of ordinary degrees of heat. Bunsen and Ste.-Claire De Ville have taught us, however, that combustion becomes extremely sluggish when a temperature of 1800° C. has been reached, and for effects at temperatures exceeding that limit the electric furnace will probably find advantageous applications. Its specific advantage consists in being apparently unlimited in the degree of heat attainable, thus opening out a new field of investigation to the chemist and metallurgist. Tungsten has been melted in such a furnace, and 8 pounds of platinum have been reduced from the cold to the liquid condition in 20 minutes.

The largest and most extensive application of electric energy at the present time is to lighting, but, considering how much has of late been said and written for and against this new illuminant, I shall here confine myself to a few general remarks. Joule has shown that if an electric current is passed through a conductor, the whole of the energy lost by the current is converted into heat; or, if the resistance be localised, into radiant energy comprising heat, light, and actinic rays. Neither the low heat rays nor the ultra-violet of highest refrangibility affect the retina, and may be regarded as lost energy, the effective rays being those between the red and violet of the spectrum, which in their combination produce the effect of white light.

Regarding the proportion of luminous to non-luminous rays proceeding from an electric arc or incandescent wire, we have a most valuable investigation by Dr. Tyndall, recorded in his work on "Radiant Heat." Dr. Tyndall shows that the luminous rays from a platinum wire heated to its highest point of incandescence, which may be taken at 1700° C., formed $\frac{1}{24}$th part of the total radiant energy emitted, and $\frac{1}{10}$th part in the case of an arc light worked by a battery of 50 Grove's elements. In order to apply these valuable data to the case of electric lighting by means of dynamo-currents, it is necessary in the first place to determine what is the power of 50 Grove's elements of the size used by Dr. Tyndall, expressed in the practical scale of units as now established. From a few experiments lately undertaken for myself, it would appear that 50 such cells have an electro-motive force of 98·5 Volts, and an internal resistance of 13·5 Ohms, giving a current of 7·3 Ampères when the cells are short-circuited. The resistance of a regulator such as Dr. Tyndall used in his experiments may be taken at 10 Ohms, the current produced in the arc would be 4 Ampères (allowing one Ohm for the leads), and the power consumed 160 Watts; the light power of such an arc would be about 150 candles, and, comparing this with an arc of 3308 candles produced by 1162 Watts, we find that 7·3 times the electric energy produce 22 times the amount of light measured horizontally. If, therefore, in Dr. Tyndall's arc $\frac{1}{10}$th of the radiant energy emitted was visible as light, it follows that in a powerful arc of 3300 candles, fully $\frac{1}{3}$ are luminous rays. In the case of the incandescence light (say a Swan light of 20 candle power) we find in practice that 9 times as much power has to be expended as in the case of the arc light; hence $\frac{1}{27}$ part of the power is given out as luminous rays, as against $\frac{1}{24}$th in Dr. Tyndall's incandescent platinum—a result sufficiently approximate considering the wide difference of conditions under which the two are compared.

These results are not only of obvious practical value, but they seem to establish a fixed relation between current, temperature, and light produced, which may serve as a means to determine temperatures exceeding the melting point of platinum with greater accuracy than has hitherto been possible by actinimetric methods in which the thickness of the luminous atmosphere must necessarily exercise a disturbing influence. It is probably owing to this circumstance that the temperature of the electric arc as well as that of the solar photosphere has frequently been greatly over-estimated.

The principal argument in favour of the electric light is furnished by its immunity from products of combustion which not only heat the lighted apartments, but substitute carbonic acid and deleterious sulphur compounds for the oxygen upon which respiration depends; the electric light

is white instead of yellow, and thus enables us to see pictures, furniture, and flowers as by daylight; it supports growing plants instead of poisoning them, and by its means we can carry on photography and many other industries at night as well as during the day. The objection frequently urged against the electric light, that it depends upon the continuous motion of steam or gas engines, which are liable to accidental stoppage, has been removed by the introduction into practical use of the secondary battery; this, although not embodying a new conception, has lately been greatly improved in power and constancy by Planté, Faure, Volckmar, Sellon, and others, and promises to accomplish for electricity what the gas-holder has done for the supply of gas and the accumulator for hydraulic transmission of power.

It can no longer be a matter of reasonable doubt, therefore, that electric lighting will take its place as a public illuminant, and that even should its cost be found greater than that of gas, it will be preferred for the lighting of drawing-rooms and dining-rooms, theatres and concert-rooms, museums, churches, warehouses, show-rooms, printing establishments and factories, and also the cabins and engine-rooms of passenger steamers. In the cheaper and more powerful form of the arc light, it has proved itself superior to any other illuminant for spreading artificial daylight over the large areas of harbours, railway stations, and the sites of public works. When placed within a holophote the electric lamp has already become a powerful auxiliary in effecting military operation both by seaand land.

The electric light may be worked by natural sources of power, such as waterfalls, the tidal wave, or the wind, and it is concivable that these may be utilised at considerable distances by means of metallic conductors. Some five years ago I called attention to the vastness of those sources of energy, and the facility offered by electrical conduction in rendering them available for lighting and power-supply, while Sir William Thomson made this important matter the subject of his admirable address to Section A last year at York, and dealt with it in an exhaustive manner.

The advantages of the electric light and of the distribution of power by electricity have lately been recognised by the British Government, who have just passed a Bill through Parliament to facilitate the establishment of electrical conductors in towns, subject to certain regulating clauses to protect the interests of the public and of local authorities. Assuming the cost of electric light to be practically the same as gas, the preference for one or other will in each application be decided upon grounds of relative convenience, but I venture to think that gas-lighting will hold its own as the poor man's friend.

Gas is an institution of the utmost value to the artisan; it requires hardly any attention, is supplied upon regulated terms, and gives with what should be a cheerful light a genial warmth, which often saves the lighting of a fire. The time is moreover not far distant, I venture to think, when both rich and poor will largely resort to gas as the most convenient, the cleanest, and the cheapest of heating agents, and when raw coal will be seen only at the colliery or the gasworks. In all cases where the town to be supplied is within say 30 miles of the colliery, the gasworks may with advantage be planted at the mouth, or still better at the bottom of the pit, whereby all haulage of fuel would be avoided, and the gas, in its ascent from the bottom of the colliery, would require an onward pressure sufficient probably to impel it to its destination. The possibility of transporting combustible gas through pipes for such a distance has been proved at Pittsburg, where natural gas from the oil districts is used in large quantities.

The quasi monopoly so long enjoyed by gas companies has had the inevitable effect of checking progress. The gas being supplied by meter, it has been seemingly to the advantage of the companies to give merely the prescribed illuminating power, and to discourage the invention of economical burners, in order that the consumption might reach a maximum. The application of gas for heating purposes has not been encouraged, and is still made difficult in consequence of the objectionable practice of reducing the pressure in the mains during daytime to the lowest possible point consistent with prevention of atmospheric indraught. The introduction of electric light has convinced gas managers and directors that such a policy is no longer tenable, but must give way to one of technical progress; new processes for cheapening the production and increasing the purity and illuminating power of gas are being fully discussed before the Gas Institute; and improved burners, rivalling the electric light in brilliancy, greet our eyes as we pass along our principal thoroughfares.

Regarding the importance of the gas supply as it exists at present, we find from a Government return that the capital invested in gasworks in England, other than those of local authorities, amounts to £30,000,000; in these 4,281,048 tons of coal are converted annually, producing 43,000 million cubic feet of gas, and about 2,800,000 tons of coke; whereas the total amount of coal annually converted in the United Kingdom may be estimated at 9,000,000 tons, and the by-products therefrom at 500,000 tons of tar, 1,000,000 tons of ammonia liquor, and 4,000,000 tons of coke, according to the returns kindly furnished me by the managers of many of the gasworks and corporations. To these may be added say 120,000 tons of sulphur, which up to the present time is a waste product.

Previous to the year 1856—that is to say, before Mr. W. H. Perkin had invented his practical process, based chiefly upon the theoretical investigations of Hofmann, regarding the coal-tar bases and the chemical constitution of indigo—the value of coal-tar in London was scarcely a halfpenny a gallon, and in country places gas makers were glad to give it away. Up to that time the coal-tar industry had consisted chiefly in separating the tar by distillation into naphtha, creosote, oils, and pitch. A few distillers, however, made small quantities of benzene, which had been first shown—by Mansfield, in 1849—to exist in coal-tar naphtha mixed with toluene, cumene, &c. The discovery, in 1856, of the mauve or aniline purple gave a great impetus to the coal-tar trade, inasmuch as it necessitated the separation of large quantities of benzene, or a mixture of benzene and toluene, from the naphtha. The trade was further increased by the discovery of the magenta or rosaniline dye, which required the same products for its preparation. In the meantime, carbolic acid was gradually introduced into commerce, chiefly as a disinfectant, but also for the production of colouring matter.

The colour industry utilises even now practically all the benzene, a large proportion of the solvent naphtha, all the anthracene, and a portion of the naphthaline resulting from the distillation of coal-tar; and the value of the colouring matter thus produced is estimated by Mr. Perkin at £3,350,000.

The demand for ammonia may be taken as unlimited, on account of its high agricultural value as a manure; and, considering the failing supply of guano and the growing necessity for stimulating the fertility of our soil, an increased production of ammonia may be regarded as a matter of national importance, for the supply of which we have to look almost exclusively to our gas-works. The present production of 1,000,000 tons of liquor yields 95,000 tons of sulphate of ammonia; which, taken at £20 10s. a ton, represents an annual value £1,947,000.

The total annual value of the gas-works by-products may be estimated as follows:—

Colouring matter	£3,350,000
Sulphate of ammonia	1,947,000
Pitch (325,000 tons)	365,000
Creosote (25,000,000 gallons)	208,000
Crude carbolic acid (1,000,000 galls.)	100,000
Gas coke, 4,000,000 tons (after allowing 2,000,000 consumption in working the retorts) at 12s... ..	2,400,000
	£8,370,000

Taking the coa used, 9,000,000 tons, at 12s., equal £5,400,000, it follows that the by-products exceed in value the coal used by very nearly £3,000,000.

In using raw coal for heating purposes these valuable products are not only absolutely lost to us, but in their stead we are favoured with those semi-gaseous by-products in the atmoshphere too well known to the denizens of Londons and other large towns as smoke. Prof. Roberts has calculated that the soot in the pall hanging over London on a winter's day amounts to fifty tons, and that the carbonic oxide, a poisonous compound, resulting from the imperfect combustion of coal, may be taken as at least five times that amount. Mr. Aitken has shown, moreover, in an interesting paper communicated to the Royal Society of Edinburgh last year, that the fine dust resulting from the imperfect combustion of coal is mainly instrumental in the formation of fog; each particle of solid matter attracting to itself aqueous vapour; these globules of fog are rendered particularly tenacious and disagreeable by the presence of tar vapour, another result of imperfect combustion of raw fuel, which might be turned to much better account at the dye-works. The hurtful influence of smoke upon public health, the great personal discomfort to which it gives rise, and the vast expense it indirectly causes through the destruction of our monuments, pictures, furniture, and apparel, are now being recognised, as is evinced by the success of recent Smoke Abatement Exhibitions. The most effectual remedy would result from a general recognition of the fact that wherever smoke is produced fuel is being consumed wastefully, and that all our calorific effects, from the largest down to the domestic fire, can be realised as completely, and more economically, without allowing any of the fuel employed to reach the atmosphere unburnt. This most desirable result may be effected by the use of gas for all heating purposes with or without the addition of coke or anthracite.

The cheapest form of gas is that obtained through the entire distillation of fuel in such gas producers as are now largely used in working the furnaces of glass, iron, and steel works; but gas of this description would not be available for the supply of towns owing to its bulk, about two-thirds of its volume being nitrogen. The use of water-gas, resulting from the decomposition of steam in passing through a hot chamber filled with coke, has been suggested, but this gas also is objectionable, because it contains, besides hydrogen, the poisonous and inodorous gas carbonic oxide, the introduction of which into dwelling-houses could not be effected without considerable danger. A more satisfactory mode of supplying heating separately from illuminating gas would consist in connecting the retort at different periods of the distillation with two separate systems of mains for the delivery of the respective gases. By resorting to improved means of heating the retorts with gaseous fuel, such as have been in use at the Paris gas-works for a considerable number of years, the length of time for effecting each distillation may be shortened from six hours, the usual period in former years, to four, or even three hours, as now practised at Glasgow and elsewhere. By this means a given number of retorts can be made to produce, in addition to the former quantity of illuminating gas of superior quality, a similar quantity of heating gas, resulting in a diminished cost of production, and an increased supply of the valuable by-products previously referred to.

The greater efficiency of gas as a fuel results chiefly from the circumstance that a pound of gas yields in combustion 22,000 heat units, or exactly double the heat produced in the combustion of a pound of ordinary coal. This extra heating power is due partly to the freedom of the gas from earthy constituents, but chiefly to the heat imparted to it in effecting its distillation. Recent experiments with gas-burners have shown that in this direction also there is much room for improvement.

The amount of light given out by a gas flame depends upon the temperature to which the particles of solid carbon in the flame are raised, and Dr. Tyndall has shown that of the radiant energy set up in such a flame, only the $\frac{1}{25}$th part is luminous; the hot products of combustion carry off at least four times as much energy as is radiated, so that not more than one-hundredth part of the heat evolved in combustion is converted into light. This proportion could be improved, however, by increasing the temperature of combustion, which may be effected either by intensified air-current or by regenerative action. Supposing that the heat of the products of combustion could be communicated to metallic surfaces, and be transferred by conduction or otherwise to the atmospheric air supporting combustion in the flame, we should be able to increase the temperature accumulatively to any point within the limit of dissociation; this limit may be fixed at about 2300° C., and cannot be very much below that of the electric arc. At such a temperature the proportion of luminous rays to the total heat produced in combustion would be more than doubled, and the brilliancy of the light would at the same time be greatly increased. Thus improved, gas-lighting may continue its rivalry with electric lighting both as regards economy and brilliancy, and such rivalry must necessarily result in great public advantage.

In the production of mechanical effect from heat, gaseous fuel also presents most striking advantages, as will appear from the following consideration. When we have to deal with the question of converting mechanical into electrical effect, or *vice versa*, by means of the dynamo-electrical machine, we have only to consider what are the equivalent values of the two forms of energy, and what precautions are necessary to avoid losses by the electrical resistance of conductors and by friction. The transformation of mechanical effect into heat involves no losses except those resulting from imperfect installation, and these may be so completely avoided that Dr. Joule was able by this method to determine the equivalent values of the two forms of energy. But in attempting the inverse operation of effecting the conversion of heat into mechanical energy, we find ourselves confronted by the second law of thermo-dynamics, which says that whenever a given amount of heat is converted into mechanical effect, another but variable amount descends from a higher to a lower potential, and is thus rendered unavailable.

In the condensing steam-engine this waste heat comprises that communicated to the condensing water, whilst the useful heat, or that converted into mechanical effect, depends upon the difference of temperature between the boiler and condenser. The boiler pressure is limited, however, by considerations of safety and convenience of construction, and the range of working temperature rarely exceeds 120° C. except in the engines constructed by Mr. Perkins, in which a range of 160° C., or an expansive action commencing at 14 atmospheres, has been adopted with considerable promise of success, as appears from an able report on this engine by Sir Frederick Bramwell. To obtain more advantageous primary conditions we have to turn to the caloric or gas-engine, because in them the coefficient of efficiency expressed by $\frac{T-T'}{T}$, may be greatly increased. This value would reach a maximum if the initial absolute temperature T could be raised to that of combustion, and T' reduced to atmospheric temperature, and these maximum limits can be much more nearly approached in the gas-engine worked by a combustible mixture of air and hydrocarbons than in the steam-engine.

Before many years have elapsed we shall find in our factories and on board our ships engines with a fuel consumption not exceeding 1 pound of coal per effective horse-power per hour, in which the gas producer takes the place of the somewhat complex and dangerous steam-boiler. The advent of such an engine and of the dynamo-machine must mark a new era of material progress at least equal to that produced by the introduction of steam power in the

early part of our century. Let us consider what would be the probable effect of such an engine upon that most important interest of this country—the merchant navy.

According to returns kindly furnished me by the Board of Trade and "Lloyds' Register of Shipping," the total value of the merchant shipping of the United Kingdom may be estimated at £126,000,000, of which £90,000,000 represent steamers having a net tonnage 3,003,988 tons; aed £36,000,000 sailing vessels, of 3,688,008 tons. The safety of this vast amount of shipping, carrying about five-sevenths of our total imports and exports, or £500,000,000 of goods in the year, and of the more precious lives connected with it, is a question of paramount importance. It involves considerations of the most varied kind: comprising the construction of the vessel itself, and the material employed in building it; its furniture of engines, pumps, sails, tackle, compass, sextant, and sounding apparatus, the preparation of reliable charts for the guidance of the navigator, and the construction of harbours of refuge, lighthouses, beacons, bells, and buoys, for channel navigation. Yet notwithstanding the combined efforts of science, inventive skill, and practical experience—the accumulation of centuries—we are startled with statements to the effect that during last year as many as 1007 British-owned ships were lost, of which fully two-thirds were wrecked upon our shores, representing a total value of nearly £10,000,000. Of these ships 870 were sailing vessels and 137 steamers, the loss of the latter being in a fourth of the cases attributable to collision. The number of sailing vessels included in these returns being 19,325, and of steamers 5505, it appears that the steamer is the safer vessel, in the proportion of 4·43 to 3·46; but the steamer makes on an average three voyages for one of the sailing-ship taken over the year, which reduces the relative risk of the steamer as compared with the sailing-ship per voyage in the proportion of 13·29 to 3·46. Commercially speaking, this factor of safety in favour of steam-shipping is to a great extent counterbalanced by the value of the steamship, which bears to that of the sailing-vessel per net carrying ton the proportion of 3:1, thus reducing the ratio in favour of steam shipping as 13·29 to 10·38, or in round numbers as 4:3.

In considering the question how the advantages thus established in favour of steam-shipping could be further improved, attention should be called in the first place to the material employed in their construction. A new material was introduced for this purpose by the Admiralty in 1876 78, when they constructed at Pembroke dockyard the two steam corvettes, the *Iris* and *Mercury*, of mild steel. The peculiar qualities of this material are such as to have enabled shipbuilders to save 20 per cent in the weight of the ship's hull, and to increase to that extent its carrying capacity. It combines with a strength 30 per cent superior to that of iron such extreme toughness that in the case of collision the side of the vessel has been found to yield or bulge several feet without showing any signs of rupture, a quality affecting the question of sea risk very favourably. When to the use of this material there are added the advantages derived from a double bottom, and from the division of the ship's hold by means of bulk-heads of solid construction, it is difficult to conceive how such a vessel could perish by collision either with another vessel or with a sunken rock. The spaces between the two bottoms are not lost, because they form convenient chambers for water ballast, but powerful pumps should in all cases be added to meet emergencies.

If to the improvements already achieved could be added an engine of half the weight of the present steam-engine and boilers, and working with only half the present expenditure of fuel, a further addition of 30 per cent could be made to the cargo of an Atlantic propeller vessel—no longer to be called a steamer—and the balance of advantages in favour of such vessels would be sufficient to restrict the use of sailing craft chiefly to the regattas of this and neighbouring ports.

The admirable work on the "British Navy," lately published by Sir Thomas Brassey, the Civil Chief Lord of the Admiralty, shows that the naval department of this country is fully alive to all improvements having regard to the safety as well as the fighting qualities of Her Majesty's ships of war, and recent experience goes far to prove that although high speed and manœuvring qualities are of the utmost value, the armour plate which appeared to be fast sinking in public favour is not without its value in actual warfare.

The progressive views perceptible in the construction of the navy are further evidenced in a remarkable degree in the hydrographic department. Captain Sir Frederick Evans, the hydrographer, and Vice-President of the British Association, gave us at York last year a very interesting account of the progress made in that department, which, while dealing chiefly with the preparation of charts showing the depth of water, the direction and force of currents, and the rise of tides near our shores, contains also valuable statistical information regarding the more general questions of the physical conditions of the sea, its temperature at various depths, its flora and fauna, as also the rainfall and the nature and force of prevailing winds. In connection with this subject the American Naval Department has taken an important part, under the guidance of Captain Maury and the Agassiz father and son, whilst in this country the persistent labours of Dr. William Carpenter deserve the highest consideration.

Our knowledge of tidal action has received a most powerful impulse through the invention of a self-recording gauge and tide-predicter, which will form the subject of one of the discourses to be delivered at our present meeting by its principal originator, Sir William Thomson.

The application of iron and steel in naval construction rendered the use of the compass for some time illusory, but in 1839 Sir George Airy showed how the errors of the compass, due to the influence experienced from the iron of the ship, may be perfectly corrected by magnets and soft iron placed in the neighourhood of the binnacle, but the great size of the needles in the ordinary compasses rendered the correction of the quadrantal errors practically unattainable. In 1876 Sir William Thomson invented a compass with much smaller needles than those previously used, which allows Sir George Airy's principle to be applied completely.

Sir William Thomson has also enriched the art of navigation by the invention of two sounding machines; the one being devised for ascertaining great depths very accurately in less than one-quarter the time formerly necessary, and the other for taking depths up to 130 fathoms without stopping the ship in its onward course. In both these instruments steel pianoforte wire is used instead of the hempen and silken lines formerly employed; in the latter machine the record of depth is obtained not by the quantity of wire run over its counter and brake wheel, but through the indications produced upon a simple pressure gauge consisting of an inverted glass tube, whose internal surface is covered beforehand with a preparation of chromate of silver, rendered colourless by the sea-water up to the height to which it penetrates. The value of this instrument for guiding the navigator within what he calls "soundings" can hardly be exaggerated; with the sounding machine and a good chart he can generally make out his position correctly by a succession of three or four casts in a given direction at given intervals, and thus in foggy weather is made independent of astronomical observations and of the sight of lighthouses or the shore. By the proper use of this apparatus, such accidents as happened to the mail steamer *Mosel* not a fortnight ago would not be possible. As regards the value of the deep-sea instrument I can speak from personal experience, as on one occasion it enabled those in charge of the Cable s.s. *Faraday* to find the end of an Atlantic Cable, which had parted in a gale of wind, with no other indication of the locality than a single sounding, giving a depth of 950 fathoms. To recover the cable a number of soundings

in the supposed neighbourhood of the broken end were taken, the 950 fathom contour line was then traced upon a chart, and the vessel thereupon trailed its grapnel two miles to the eastward of this line, when it soon engaged the cable 20 miles away from the point, where dead reckoning had placed the ruptured end.

The time allowed me for addressing you on this occasion is wholly insufficient to do justice to the great engineering works of the present day, and I must therefore limit myself to making a short allusion to a few only of the more remarkable enterprises.

The great success, both technically and commercially, of the Suez Canal has stimulated M. de Lesseps to undertake a similar work of even more gigantic proportions, namely, the piercing of the Isthmus of Panama by a ship canal, 40 miles long, 50 yards wide on the surface, and 20 yards at the bottom, upon a dead level from sea to sea. The estimated cost of this work is £20,000,000; and more than this sum having been subscribed, it appears unlikely that political or climatic difficulties will stop M. de Lesseps in its speedy accomplishment. Through it China, Japan, and the whole of the Pacific Ocean, will be brought to half their present distance, as measured by the length of voyage, and an impulse to navigation and to progress will thus be given which it will be difficult to overestimate.

Side by side with this gigantic work, Captain Eads, the successful improver of the Mississippi navigation, intends to erect his ship railway, to take the largest vessels, fully laden and equipped, from sea to sea, over a gigantic railway across the Isthmus of Tehuantepec, a distance of 95 miles. Mr. Barnaby, the chief constructor of the navy, and Mr. John Fowler have expressed a favourable opinion regarding this enterprise, and it is to be hoped that both the canal and the ship railway will be accomplished, as it may be safely anticipated that the traffic will be amply sufficient to support both these undertakings.

Whether or not M. de Lesseps will be successful also in carrying into effect the third great enterprise with which his name has been prominently connected, the flooding of the Tunis-Algerian Chotts, thereby re-establishing the Lake Tritonis of the ancients, with its verdure-clad shores, is a question which could only be decided upon the evidence of accurate surveys, but the beneficial influence of a large sheet of water within the African desert could hardly be matter of doubt.

It is with a feeling not unmixed with regret that I have to record the completion of a new Eddystone Lighthouse in substitution for the *chef-d'œuvre* of engineering erected by John Smeaton more than 100 years ago. The condemnation of that structure was not, however, the consequence of any fault of construction, but was caused by inroads of the sea upon the rock supporting it. The new lighthouse, designed and executed by Mr., now Sir, James Douglass, engineer of Trinity House, has been erected in the incredibly short time of less than two years, and bids fair to be worthy of its famed predecessor. Its height above high water is 130 feet, as compared with 72 feet, the height of Telford's structure, which gives its powerful light a considerably increased range. The system originally suggested by Sir William Thomson, some years ago, of distinguishing one light from another by flashes following at varied intervals, has been adopted by the Elder Brethren in this as in other recent lights in the modified form introduced by Dr. John Hopkinson, in which the principle is applied to revolving lights, so as to obtain a greater amount of light in the flash.

The geological difficulties which for some time threatened the accomplishment of the St. Gothard Tunnel have been happily overcome, and this second and most important sub-Alpine thoroughfare now connects the Italian railway system with that of Switzerland and the south of Germany, whereby Genoa will be constituted the shipping port for those parts.

Whether we shall be able to connect the English with the French railway system by means of a tunnel below the English Channel is a question that appears dependent at this moment rather upon military and political than technical and financial considerations. The occurrence of a stratum of impervious grey chalk, at a convenient depth below the bed of the Channel, minimises the engineering difficulties in the way, and must influence the financial question involved. The protest lately raised against its accomplishment can hardly be looked upon as a public verdict, but seems to be the result of a natural desire to pause pending the institution of careful inquiries. These inquiries have been made by a Royal scientific Commission, and will be referred for further consideration to a mixed Parliamentary Committee, upon whose Report it must depend whether the natural spirit of commercial enterprise has to yield in this instance to political and military considerations. Whether the Channel Tunnel is constructed or not, the plan proposed some years ago by Mr John Fowler of connecting England and France by means of a ferry-boat capable of taking railway trains would be a desideratum justified by the ever-increasing intercommunication between this and Continental countries.

The public inconvenience arising through the obstruction to traffic by a sheet of water is well illustrated by the circumstance that both the estuaries of the Severn and of the Mersey are being undermined in order to connect the railway systems on the two sides, and that the Frith of Forth is about to be spanned by a bridge exceeding in grandeur anything as yet attempted by the engineer. The roadway of this bridge will stand 150 feet above high-water mark, and its two principal spans will measure a third of a statute mile each. Messrs. Fowler and Baker, the engineers to whom this great work has been entrusted, could hardly have accomplished their task without having recourse to steel for their material of construction, nor need the steel used be of the extra mild quality particularly applicable for naval structures to withstand collision, for, when such extreme toughness is not required, steel of very homogeneous quality can be produced, bearing a tensile strain double that of iron.

When the British Association met at Southampton on a former occasion, Schönbein announced to the world his discovery of gun-cotton. This discovery has led the way to many valuable researches on explosives generally, in which Mr. Abel has taken a leading part. Recent investigations by him, in connection with Captain Noble, upon the explosive action of gun-cotton and gunpowder confined in a strong chamber, which have not yet been published, deserve particular attention. They show that while by the method of investigation pursued about twenty years ago by Karoyle (of exploding gunpowder in very small charges in shells confined within a large shell partially exhausted of air), the composition of the gaseous products was found to be complicated and liable to variation, the chemical metamorphosis which gun-cotton sustains, when exploded under conditions such as obtain in its practical application, is simple and very uniform. Among other interesting points noticed in this direction was the fact that, as in the case of gunpowder, the proportion of carbonic acid increases, while that of carbonic oxide diminishes with the density of the charge.

Messrs. Noble and Abel are also continuing their researches upon fired gunpowder, being at present occupied with an inquiry into the influence exerted upon the chemical metamorphosis and ballistic effects of fired gunpowder by variation in its composition, their attention being directed especially to the discovery of the cause of the more or less considerable erosion of the interior surface of guns produced by the exploding charge—an effect which, notwithstanding the application of devices in the building up of the charge specially directed to the preservation of the gun's bore, have become so serious that, with the enormous charges now used in our heavy guns, the erosive action on the surface of the bore produced by a single round is distinctly perceptible. As there appeared

to be *primâ facie* reasons why the erosive action of powder upon the surface of the bore at the high temperatures developed should be at any rate in part due to its one component sulphur, Noble and Abel have made comparative experiments with powders of usual composition and with others in which the proportion of sulphur was considerably increased, the extent of erosive action of the products escaping from the explosion vessel under high tension being carefully determined. With small charges a particular powder containing no sulphur was found to exert very little erosive action as compared with ordinary cannon powder; but another powder, containing the maximum proportion of sulphur tried (15 per cent), was found equal to it under these conditions, and exerted very decidedly less erosive action than it, when larger charges were reached. Other important contributions to our knowledge of the action of fired gunpowder in guns, as well as decided improvements in the gunpowder manufactured for the very heavy ordnance of the present day, may be expected to result from a continuance of these investigations. Prof. Carl Himly, of Kiel, having been engaged upon investigations of a similar nature, has lately proposed a gunpowder in which hydrocarbons precipitated from solution in naphtha take the place of the charcoal and sulphur of ordinary powder; this powder has, amongst others, the peculiar property of completely resisting the action of water, so that the old caution "Keep your powder dry" may hereafter be unnecessary.

The extraordinary difference of condition, before and after its ignition, of such matter as constitutes an explosive agent, leads up to a consideration of the aggregate state of matter under other circumstances. As early as 1776 Alexander Volta observed that the volume of glass was changed under the influence of electrification, by what he termed electrical pressure. Dr. Kerr, Govi, and others have followed up the same inquiry, which is at present continued chiefly by Dr. George Quincke, of Heidelberg, who finds that temperature, as well as chemical constitution of the dielectric under examination, exercises a determining influence upon the amount and character of the change of volume effected by electrification; that the change of volume may under certain circumstances be effected instantaneously as in flint glass, or only slowly as in crown glass, and that the elastic limit of both is diminished by electrification, whereas in the case of mica and of gutta-percha an increase of elasticity takes place.

Still greater strides are being made at the present time towards a clearer perception of the condition of matter when particles are left some liberty to obey individually the forces brought to bear upon them. By the discharge of high tension electricity through tubes containing highly rarefied gases (Geissler's tubes), phenomena of discharge were produced which were at once most striking and suggestive. The Sprengel pump afforded a means of pushing the exaustion to limits which had formerly been scarcely reached by the imagination. At each step the condition of attenuated matter revealed varying properties when acted upon by electrical discharge and magnetic force. The radiometer of Crookes imported a new feature into these inquiries, which at the present time occupy the attention of leading physicists in all countries.

The means usually employed to produce electrical discharge in vacuum tubes was Ruhmkorff's coil; but Mr. Gassiot first succeeded in obtaining the phenomena by means of a galvanic battery of 3000 Leclanché cells. Dr. De la Rue, in conjunction with his friend, Dr. Hugo Müller, has gone far beyond his predecessors in the production of batteries of high potential. At his lecture "On the Phenomena of Electric Discharge," delivered at the Royal Institution in January, 1881, he employed a battery of his invention consisting of 14,400 cells (14,832 Volts), which gave a current of 0·054 Ampère, and produced a discharge at a distance of 0·71 inch between the terminals. During last year he increased the number of cells to 15,000 (15,450 Volts), and increased the current to 0·4 Ampère, or eight times that of the battery he used at the Royal Institution.

On the occasion of his lecture, Dr. De la Rue produced, in a very large vacuum tube, an imitation of the Aurora Borealis; and he has deduced from his experimeats that the greatest brilliancy of Aurora displays must be at an altitude of from 37 to 38 miles—a conclusion of the highest interest, and in opposition to the extravagant estimate of 281 miles at which it had been previously put.

The President of the Royal Society has made the phenomena of electrical discharge his study for several years, and resorted in his important experiments to a special source of electric power. In a note addressed to me, Dr. Spottiswoode describes the nature of his investigations much more clearly than I could venture to give them. He says: "It had long been my opinion that the dissymmetry shown in electrical discharges through rarefied gases must be an essential element of every disruptive discharge, and that the phenomena of stratification might be regarded as magnified images of features always present, but concealed under ordinary circumstances. It was with a view to the study of this question that the researches by Moulton and myself were undertaken. The method chiefly used consisted in introducing into the circuit intermittence of a particular kind, whereby one luminous discharge was rendered sensitive to the approach of a conductor outside the tube. The application of this method enabled us to produce artificially a variety of phenomena, including that of stratification. We were thus led to a series of conclusions relating to the mechanism of the discharge, among which the following may be mentioned:—

"1. That a stria, with its attendant dark space, forms a physical unit of a striated discharge.

"2. That the origin of the luminous column is to be sought for at its negative end; that the luminosity is an expression of a demand for negative electricity.

"3. That the time occupied by electricity of either name in traversing a tube is greater than that occupied in traversing an equal length of wire, but less than that occupied by molecular streams (Crookes's radiations) in traversing the tubes.

"4. That the brilliancy of the light with so little heat may be due in part to brevity in the duration of the discharge.

"5. That striæ are not merely loci in which electrical is converted into luminous energy, but are actual aggregations of matter.

"This last conclusion was based mainly upon experiments made with an induction coil excited in a new way,—viz., directly by an alternating machine, without the intervention of a commutator or condenser. This mode of excitement promises to be one of great importance in spectroscopic work, as well as in the study of the discharge in a magnetic field, partly on account of the simplication which it permits in the construction of induction coils, but mainly on account of the very great increase of strength in the secondary currents to which it gives rise."

These investigations assume additional importance when we view them in connection with solar—I may even say stellaar—physics, for evidence is augmenting in favour of the view that interstellar space is not empty, but is filled with highly attenuated matter of a nature such as may be put into our vacuum tubes. Nor can the matter occupying stellar space be said any longer to be beyond our reach for chemical and physical test. The spectroscope has already thrown a flood of light upon the chemical constitution and physical condition of the sun, the stars, the comets, and the far distant nebulæ, which have yielded spectroscopic photographs under the skilful management o Dr. Huggins, and Dr. Draper, of New York. Armed with greatly improved apparatus the physical astronomer has been able to reap a rich harvest of scientific information during the short periods of the last two solar eclipses; that of 1879, visible in America, nd that of May last, observed in Egypt by Lockyer

Schuster, and by Continental observers of high standing. The result of this last eclipse expedition has been summed up as follows: "Different temperature levels have been discovered in the solar atmosphere; the constitution of the corona has now the possibility of being determined, and it is proved to shine with its own light. A suspicion has been aroused once more as to the existence of a lunar atmosphere, and the position of an important line has been discovered. Hydrocarbons do not exist close to the sun, but may in space between us and it."

To me personally these reported results possess peculiar interest, for in March last I ventured to bring before the Royal Society a speculation regarding the conservation of solar energy, which was based upon the three following postulates, viz. :—

1. That aqueous vapour and carbon compounds are present in stellar or interplanetary space.

2. That these gaseous compounds are capable of being dissociated by radiant solar energy while in a state of extreme attenuation.

3. That the effect of solar rotation is to draw in dissociated vapours upon the polar surfaces, and to eject them after combustion has taken place back into space equatorially.

It is therefore a matter of peculiar gratification to me that the results of observation here recorded give considerable support to that speculation. The luminous equatorial extensions of the sun which the American observations revealed in such a striking manner (with which I was not acquainted when writing my paper), were absent in Egypt; but the outflowing equatorial streams I suppose to exist could only be rendered visible by reflected sunlight, when mixed with dust produced by exceptional solar disturbances or by electric discharge; and the occasional appearance of such luminous extensions would serve only to disprove the hypothesis entertained by some, that they are divided planetary matter, in which case their appearance should be permanent. Professor Langley, of Pittsburg, has shown by means of his Bolometer, that the solar actinic rays are absorbed chiefly in the solar instead of in the terrestrial atmosphere, and Captain Abney has found by this new photometric method that absorption due to hydrocarbons takes place somewhere between the solar and the terrestrial atmosphere; in order to test this interesting result still further, he has lately taken his apparatus to the top of the Riffel with a view of diminishing the amount of terrestrial atmospheric air between it and the sun, and intends to bring a paper on this subject before Section A. Stellar space filled with such matter as hydro-carbon and aqueous vapour would establish a material continuity between the sun and his planets, and between the innumerable solar systems of which the universe is composed. If chemical action and reaction can further be admitted, we may be able to trace certain conditions of thermal dependence and maintenance, in which we may recognise principles of high perfection, applicable also to comparatively humble purposes of human life.

We shall thus find that in the great workshop of nature there are no lines of demarcation to be drawn between the most exalted speculation and common-place practice, and that all knowledge must lead up to one great result, that of an intelligent recognition of the Creator through His works. So then, we members of the British Association and fellow-workers in every branch of science may exhort one another in the words of the American bard who has so lately departed from amongst us :—

> Let us then be up and doing,
> With a heart for any fate;
> Still achieving, still pursuing,
> Learn to labour and to wait.

Salicylic Acid in Violets.—Prof. Maudelin maintains that *Viola syrtica*, *V. tricolor*, and *V. arvensis*, contain from 0·083 to 0·144 per ct. of salicylic acid.—*Cosmos les Mondes.*

THE HUDDERSFIELD LEAD-POISONING CASE.

An action for damages for injury resulting from the use of a public water-supply has recently been decided at the Yorkshire Summer Assizes. As the case appears to have escaped the Metropolitan journals, and as, in addition to its strictly scientific bearings, it must prove instructive to all interested in the supply of water to towns, we shall notice its principal features at some length.

The facts of the case were these:—Mr. J. J. Milnes, a solicitor practising at Huddersfield, and living at Long Lane, Dalton, in the outskirts of that town, was attacked about a year ago, first with violent colic, and ultimately with wrist-drop, and the other usual symptoms of lead-poisoning. He lost almost entirely the use of his arms, his brain was affected, and at one time his life seemed in peril. He has, subsequently, under able medical treatment, partially recovered the use of his limbs, but is said to be still unable, *e.g.*, to dress himself. The fact that the patient was suffering from lead-poisoning being beyond all dispute, the question arose as to how the noxious metal was introduced into his system. It appears that the water-supply, which, as in most towns of the north of England, is the property of the Corporation, is derived from several reservoirs, Mr. Milne's house being served from the so-called "Blackmoorfoot" reservoir. All the various water-sources are remarkably free, both from organic and mineral impurities, and are consequently exceedingly soft,—that from the Blackmoorfoot dam being perhaps the purest. Unfortunately, in virtue of that very purity, it is, though perfectly wholesome in the reservoirs, channels, and mains, capable of acting upon lead service-pipes. Concerning the immediate cause and *modus operandi* of this action differences of opinion prevail, to which we may advert below. But in samples of water drawn in the plaintiff's house, Mr. Jarmain, borough analyst for Huddersfield, found lead to the amount of 0·34 grain per gallon; Mr. Fairley, the Leeds public analyst, gave the quantity of lead as 0·4 grain, whilst Mr. A. Allen, the analyst for Sheffield, found in two samples respectively 0·77 and 0·84 grain of lead per gallon. On the other hand, Dr. Tidy found in a sample of water from the plaintiff's kitchen, only 0·01, and in that from his wash-house 0·04 grain per gallon. These discrepancies are quite intelligible without casting any reflection upon the accuracy of the chemists above named. The contamination of lead being derived from the service-pipes which the water traversed on its way from the mains, it is plain that different samples must vary largely according to the time the water had been allowed to stand in them before being drawn. We do not in the least doubt that a sample taken early in the morning might contain the proportion of lead as given by Mr. Allen. It is a wise precaution in all cases where a soft water has to traverse lead pipes to let it flow for some minutes in the morning, so as to empty the pipes, before taking any for culinary uses.

We now come to the important point: Does the water of the Blackmoorfoot dam dissolve lead more rapidly than soft waters generally, and if so, wherefore? Mr. Jarmain, in an official report given in to the Corporation as it appears in 1879, states that the Blackmoorfoot water very closely resembles that supplied by the Manchester Corporation. Indeed, the waters of Halifax, Bradford, Leeds, Batley, Sheffield, and Manchester, as well as that from most of the Huddersfield reservoirs, if allowed to lodge in a lead pipe for twelve hours, all took up appreciable quantities of the metal. Dr. Robertson is even reported to have said that the Manchester water has been found to contain 0·3 grain of the poisonous metal per gallon. Hence we must conclude that the Blackmoorfoot water does not form any marked exception to other mountain waters.

It may, of course, be asked why, if lead be so generally present, or liable to be present in pipe-waters, is painter's

colic not more common? In reply, we may refer to the testimony of the medical witnesses that such cases are not rare, and that lead is exceedingly capricious in its action. A man's power of resisting lead, or, indeed, many other poisons, stands in no perceptible relation to his apparent health and vigour.

As regards the solvent action of the water in question it was admitted to have an acid reaction. This was due to the presence of sulphuric acid, as was shown by Dr. Tidy. Here there arose a difference of opinion: Dr. Tidy, Prof. Odling, and Mr. Crookes were of opinion that sulphuric acid, if present in small quantities, must tend to protect the pipes from the action of the water, a thin layer of the insoluble, or at least very sparingly soluble, lead sulphate being formed. Mr. Allen took a different and, we must say, a novel view. He said that sulphuric acid would cause corrosion. He is reported as having said that he disagreed with the high scientific authorities who held that sulphuric acid neutralised the solvent effects of water. This point is of sufficient importance to require especial experimental examination. The origin of the sulphuric acid was supposed to be this: The Blackmoorfoot dam receives certain ferruginous springs. The iron-salts thus introduced, on being diffused in the water and exposed to air, become split up into a basic salt, which is deposited, and free acid, or rather, perhaps, an acid salt, which remains in solution. As a remedy, Mr. Jarmain had recommended the addition of lime-water. But Dr. Tidy pointed out that this expedient was not free from risk, as, if the quantities of lime and acid were not nicely proportioned, the mischief might be increased. An opinion was expressed which is, we believe, gaining ground in explanation of the frequent action of soft pure waters upon boiler plates, *e.g.*, at Glasgow, viz., that the agency of corrosion is the oxygen held in solution in the water. If this is proved to be the case, its prevention will be very difficult, since a thorough de-aërating of the water, even if practicable, would cause it to be disliked, by many persons, as flat and insipid.

This question, the action of soft waters upon lead pipes, becomes weighty, in view of the proposals made to supply London with soft mountain water from Wales or Cumberland.

A material for service-pipes free from the objections which attach to lead is a desideratum. Block-tin is too costly; alloys of lead and tin are as objectionable as pure lead; iron is too inflexible, and gutta-percha, which was at one time recommended, has failed to give satisfaction.

ON A

NOVEL APPLICATION OF ELECTROLYSIS IN DYEING AND PRINTING.

By M. F. GOPPELSRŒDER.

Since his former communications on the electrolytic formation of colouring matters the author has obtained further results.

1. To produce aniline-black upon cloth or paper he saturates them with an aqueous solution of a salt of aniline, preferably the hydrochlorate. He places them upon a plate of metal not capable of being attacked by the solution, and in contact with one of the poles of a galvanic battery or a small dynamo-electric machine. He places upon the cloth or paper a second metallic plate, which bears in relief the design to be produced, and which is in contact with the other pole. On giving the necessary pressure and causing the current to pass, a copy of the design is obtained in black. He has also in this manner reproduced medals and coins. Further, it is easy to write with a pencil of a metal which is not attacked or of conductive carbon, forming one of the poles, upon the tissue or paper saturated with the solution of aniline salt, and laid upon a metal plate which forms the other pole. Wherever the pencil, lightly pressed, touches the material the current passes, and there is a development of black, which is fixed upon the fibre with the same solidity as blacks produced by the ordinary methods. This method may be employed in manufacturing establishments for marking pieces with a solid colour, black or otherwise, capable of resisting the operations of bleaching, dyeing, and printing. The author has confined himself to speak of the formation and simultaneous fixation of aniline-black, but his method applies to every other colouring-matter capable of being as readily formed by oxidation or dehydrogenation, and of being fixed upon tissues.

2. The same method of operation may serve for the discharge of colours fixed upon cloth, *e.g.*, Turkey-red or indigo-blue. The dyed pieces are saturated with a solution of nitrates, such as saltpetre, or chlorides, such as sodium and aluminium chlorides. At the positive pole there is produced nitric acid or chlorine, which attacks the colour, changing it into colourless oxidation-products, so that the parts of the cloth in contact with the relief of the second plate becomes decolourised. We obtain thus a white discharge on a red, blue, &c., ground. By selecting salts whose bases may play the part of mordants, we may thus, by a dye-bath, produce new colours at the discharged parts. It is also possible that certain oxides set free by the action of the current, of the higher oxides and colours formed by the same action, may fix themselves upon the cloth and impart to it their colour. The author hopes soon to make known the reactions of the various salts in presence of the fibres under the influence of the current, as well as of the colours and mordants to which they may give rise. But there is still another manner of discharging, forming, and fixing colours simultaneously. If we saturate tissues (Turkey-red or indigo-blue) with aniline hydrochlorate, there will be on passing the current, not merely discharge of the colour, but at the same time formation of aniline-black.

3. There are also cases where the negative electrode plays the principal part. The oxidation of colours during printing may be prevented by plunging the negative electrode of a battery or of a small dynamo-electric machine into the colour-trough which contains the colour to be printed on, and placing the contents of this principal trough in communication with a very small secondary trough, which contains either the same colour or any liquid conductor, into which is plunged the positive electrode. The communication is made either by a septum of parchment-paper, or of porous clay, or by a tube. The hydrogen is evolved at the negative pole in the midst of the colour to be printed, and hinders oxidation. It is possible to precipitate upon the fibres heavy or precious metals. It is merely necessary to impregnate the cloth with a solution, properly thickened, of a salt of any of these metals, and to let the negative electrode act in order to precipitate the metal upon the fibre.

4. The current may also be used for preparing vats of indigo, aniline-black, &c., utilising the hydrogen which is liberated at the negative pole. The colour is thus reduced as effectually as by the ordinary methods. When such vats are prepared their oxidation may be prevented by causing the negative electrode of a feeble continuous current to act upon them. A separation, as perfect as possible, of the two electrodes is required, which will not present any difficulties.—*Comptes Rendus.*

Existence of "Azobihydre" (H_2N).—E. Maumené.—The author calls in question the accuracy of the conclusions of MM. Wurtz and Combes, who have not succeeded in verifying his results. He appends the remark that "modern chemistry is more than imperfect."—*Cosmos Les Mondes.*

THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.*

By Prof. J. W. MALLET, F.R.S., University of Virginia.

(Continued from p. 75.)

General Remarks on other Chemical Determinations.

1. The determinations of total solids left on evaporation, of the loss on ignition of this solid residue, and even of chlorine, in the series of varied dilutions of identical or nearly identical liquids, show discrepancies which illustrate the comparative roughness of the methods by which these results were obtained when very small quantities have to be dealt with.† The evaporation of 100 c.c. of water usually left a residue, the absolute weight of which was but a few milligrms., and a very little difference in the dryness attained, or in the atmospheric deposition on the surface of the platinum capsule, involved relatively large errors in the result. Even the volumetric processes for chlorine are far inferior in delicacy to those employed for the organic constituents.

2. As regards the results for nitrites and nitrates, the coincidence seems to be worth noting, which is often presented between alkaline reaction of a water and the occurrence of these salts in considerable or large quantity, suggesting as this does a recollection of the conditions under which nitrates are produced on the large scale in the decay of nitrogenous organic matter. The coincidence, however, is not always observable, nitrites and nitrates occurring pretty largely in some cases without alkaline reaction, while in other instances (as Nos. 89, 90, and 91, containing the washings from starch manufacture) there was alkaline reaction, and also much nitrogenous matter, but no nitrites or nitrates. Mr. Noyes has drawn my attention to the fact that in the waters containing large amounts of nitrates, ammonia appears in but small proportion; hence ammonium nitrate seems to be rare, the basis constituent being rather for the most part non-volatile—no doubt calcium, magnesium, or one of the alkaline metals; this is worth notice in relation to possible reduction to nitrite and consequent loss of nitrogen in the combustion process. The view of Frankland that nitrites are producible in water by the reducing action of organic matter upon nitrates‡ is clearly sustained by the results for Nos. 64 and 65, these representing a water originally containing nitrates to which different amounts of an infusion of hay had been added; it seems by no means established that nitrites are *always* developed by reduction, some of Dr. Tanner's experiments which have been reported indicating that, on the contrary, these salts may be produced by oxidation, which, if it go on, leads to the formation of nitrates. Frankland's view, also, that nitrates are not found in waters deficient in dissolved oxygen, is in general accordance with the results obtained in this investigation, though there are a few instances,—Nos. 20, 27, 43, and notably 33—in which nitrates are present to a considerable extent in waters with less than a full proportion of free oxygen in solution.

3. The experiments with tannin simply serve to show how utterly worthless is this "group-reagent" of Kämmerer for the purpose for which he has advocated its use.

4. The general series of analyses of the dissolved gases confirms what has been said on previous pages of the general report as to the number of varying conditions which influence the results in this direction—oxidisability of organic matter present, temperature, extent of exposure to the atmosphere, and interchange with it in both directions of gaseous constituents. In a number of cases the consumption of dissolved oxygen, and production in its place of carbon dioxide from the carbon of organic matter, is very obvious, but the extent to which this is found going on varies greatly, and is masked by the escape to a greater or less extent of the latter gas and re-absorption from the air of the former. The conclusion of Weyl and Zeitler,* from a few experiments, that the quantity of free oxygen in solution does not bear any fixed ratio to the quantity of acidified permanganate decolourised by a water, is sustained by many of the specimens in the main series, as for instance Nos. 60 to 80, inclusive. Nevertheless, it may be well to include an examination of the dissolved gases in the study of any water in regard to which the fullest chemical information is desired. In such a case the examination ought to be made with the least possible interval of time after collection of the sample, and preferably on the spot where the sample is taken, with observation of the temperature of water and air.

Microscopical and Pathological Results.

Feeling my own incompetence properly to discuss these, I prefer to leave them to speak for themselves, except so far as Professor Martin has, as quoted in a previous part of the general report, given his views as to the methods employed and the general significance of the facts recorded—these views having been formed, however, while he still was ignorant of the history of the individual waters.

It may be said, I think, that the microscopic and culture observations indicate at the same time the real importance of connecting with a chemical examination of water a study in competent hands of its microscopic organisms, both as to number and kind, and also the difficulty often presented either by the sparseness or more frequently the abundance of these organisms, in fairly estimating their average relation to the mass of water. This difficulty is super-added, of course, to the imperfection of our knowledge as to the effects upon human health of some closely allied—even hardly distinguishable—organisms, of dangerous and harmless associations, and of perhaps the same organism in different stages of its life history. The probable general significance of certain large classes of organised forms seems, however, well established, and well worthy of attention.

It may also be said of the pathological experiments with rabbits, that, opening up as they do a new and almost untried field of research, they show the great complexity of conditions to be encountered, the necessity of careful attention to details, and of multiplying and varying such experiments as far as possible, and the caution which must be exercised in drawing generalised conclusions from them; but on the other hand the results so far obtained, many of which individually are exceedingly suggestive, seem to indicate that real value attaches to this method of investigation, not in the direction proposed by Emmerich (as a part of the ordinary examination of a drinking water, in order to determine directly its wholesomeness or the reverse), but as the means in part of arriving at trustworthy grounds for the interpretation of chemical and microscopical results.

Sanitary Conclusions and Interpretation of Results.

To admit of easier comparison the results by the chief processes examined have been thrown into graphical form in Tables XIX. and XX., of which the former refers to the natural waters and the latter to those artificially prepared. (These Tables will appear with the general report.)

Chemical Results contrasted with Actual Sanitary History of the Natural Waters examined.

1. An inspection of Table XIX. shows that *no strongly marked generic difference is presented by the results from*

* Preliminary Report on the results of an investigation, made by direction of the National Board of Health, as to the chemical methods in use.

† It is true that Dr. Smart took no very special pains with these determinations, which were looked upon merely as incidental to the main object, checking to some extent the information as to the general character of each water. Still, this part of the work was done with fully average ordinary care.

‡ "Water Analysis," pp. 28 and 42.

* *Zeitschr. f. phys. Chem.* 5; 10 (1880).

any of the processes for the estimation of organic matter or its elements between the generally wholesome waters of Class I. and the medically condemned and fairly assumed as pernicious waters of Class II. Judging by the general impression of the curves upon the eye, one would be inclined to attribute somewhat more importance to the results involving nitrogen than to those dependent upon carbon, but neither will afford the means of broadly distinguishing the two classes. This conclusion is otherwise illustrated by the figures in Table XXI.

TABLE XXI.—*Comparison of Chemical results for Waters of Classes I. and II.*

	Least Result.		Greatest Result.		Average.	
	Class I.	Class II.	Class I.	Class II.	Class I.	Class II.
Organic carbon—	0·36	0·33	7·20	7·79	2·36	2·08
Organic nitrogen—	0·08	0·03	1·41	*6·88	0·56	†0·94
Sum of organic carbon and nitrogen—	0·44	0·61	7·86	†8·31	2·92	†2·92
Nitrogen of free ammonia—	0·008	0·008	0·675	0·295	0·092	0·090
Nitrogen of albumenoid ammonia—	0·016	0·021	0·268	+0·214	0·112	0·099
Nitrogen of total ammonia—	0·028	0·033	0·704	0·343	0·204	0·189
Oxygen consumed in one hour (Tidy)—	0·062	0·082	4·008	3·340	0·995	0·791
Oxygen consumed in three hours (Tidy)—	0·210	0·104	5·212	4·188	1·305	1·065
Oxygen consumed (Kubel)—	None	None	7·443	6·000	2·140	1·271

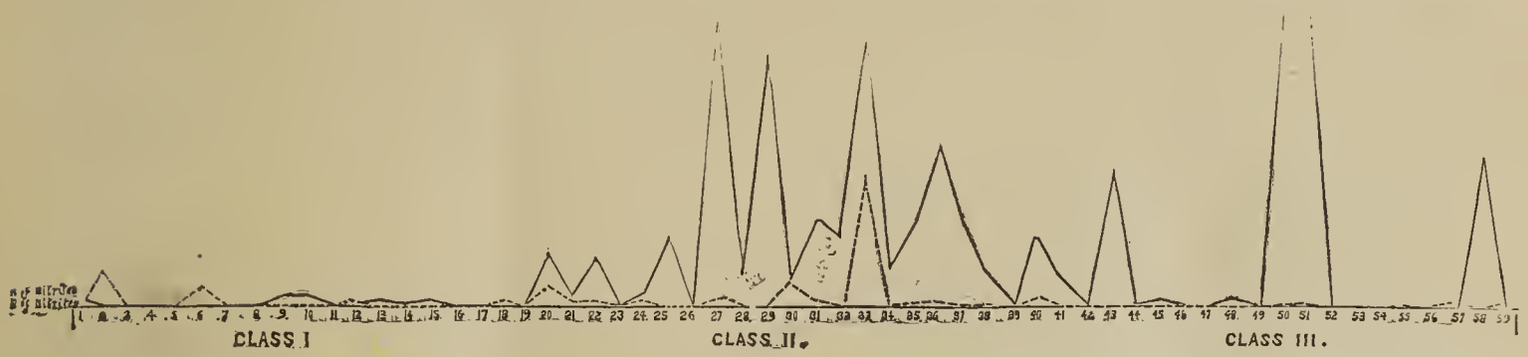
It will be seen from this table that no marked difference exists between the *highest*, *lowest*, or *average* result obtained by any of the processes for the waters of Class I. and the corresponding result for those of Class II. No one could, with these figures to guide him, refer a water of unknown origin to one or the other of the two classes on the evidence afforded by chemical analysis, using any or all of the processes in question. The more varied results presented in Class III. admit of being studied with some interest in connection with the history of the individual waters, but are not available for the main purpose of testing the chemical methods, as this class includes only waters the sanitary character of which in advance of examination was more or less doubtful—waters under suspicion only.

2. Making the most liberal allowance for the imperfection of the different processes for the estimation of organic mat er or its constituents, it is well worthy of notice how very small is the absolute amount of organic matter indicated as present in many of the most dangerous waters, an amount so small as to furnish important evidence against any chemical theory of the production of disease from this source, any theory based on the simple assumption that some of the chemical products of the decomposition of organic matter are poisonous or noxious in their effect upon the human system. Thus, if *the whole* of the organic carbon and nitrogen found in such waters as Nos. 35 and 36, of the highly dangerous character of which there can scarcely be a doubt, existed as strychnine, it would be necessary to drink about half a gallon of the water at once in order to swallow an average *medicinal* dose of the alkaloid. It is not easy to believe that the ptomaines, or any other chemical products of putrefactive change as yet observed, can possess an intensity of toxic power so very much greater than that of the most energetic of recognised poisons. While numerous facts go to support the belief that, not to the effect of any chemical substances (such effect necessarily standing in definite relation to their quantity), but to the presence of living organisms with their power of practically unlimited self-multiplication, we must in all probability look for an explanation of, most at any rate, of the mischief attributable to drinking water, it is of course possible that indirectly a large amount of organic matter in water may be more dangerous than a smaller quantity, as furnishing on a greater scale the suitable material and conditions for the development of noxious as well as harmless organisms.*

Whether variations in the mere quantity of organic matter, within such limits as occur in water at all likely to be used for drinking, are of much importance in this respect, *i.e.*, as determinant of the presence or abundance of organisms, is a question which may be asked, and on it depends, I think, largely the utility of all attempts to determine or estimate the quantity of organic matter or its constituents as such.

3. A much more conspicuous difference between the waters of Classes I. and II. is presented by the results for nitrites and nitrates, as shown in Table XXII.

In this table a tenfold height is given to the ordinates



representing the nitrites, the smaller quantity in which they occur requiring this exaggeration.

Here we find a very obvious connection between the results of chemical examination and the khown sanitary character of the several waters, the salts of nitrous and nitric acid being rather absent or present in but trifling amount in the waters of Class I., believed to be wholesome, almost universally present, and in many cases of large quantity, in the pernicous waters of Class II., and very variable as to presence and amount in waters grouped together under the doubtful head of Class III. No aspect in which I have compared together the good and bad natural waters has afforded so definite a result as this.

This result is worthy of special attention in view of the different opinions which have been expressed as to the sanitary significance of nitrites and nitrates in water. Thus, Wanklyn says:† "The nitrates and nitrites have been erroneously regarded as measuring the defilement of water." "In fine, presence or abundance of nitrates does not show defilement by means of sewage, and

* This figure is undoubtedly too high, in consequence of incomplete reduction of nitrates. The next highest is 2·36, and even this is probably higher than the truth for the same reason.

† Including the no doubt erroneous highest ingle figure.

* Tiemann and Preusse have suggested that a polluted water may more *probably* contain disease ferments than a pure one, but it should not be inferred that an impure water is necessarily pernicious. Quoted in CHEM. NEWS, January 16, 1880, 30, 31.

† J. A. Wanklyn, "Water Analysis," Lond., 1879 97, 98.

deficiency of nitrates does not show absence of defilement. Many excellent waters have been condemned as unwholesome on account of the nitrates contained by them; and it cannot too strongly be insisted upon that the nitrates afford no data of any value in judging of the organic quality of a water." Angus Smith says :*

"There are many interesting questions to be asked regarding nitrates. I am inclined to think that their presence shows that the most dangerous state of the organic matter is past. When they appear in any solution, the chief escape of putrid gas seems to have ceased; the water may, however, be still dangerous to use, and, of course, is revolting to the imagination." . . . . †"Those nitrates, however, which do remain indicate that at least an equivalent of albuminous matter or sewage matter *did* exist."

Frankland clearly expresses his view‡ as to this evidence of "previous sewage contamination" thus :—

"Large quantities [of nitrates] convict water of previous pollution by organic matters of animal origin. They tell only of the contamination which is past; but by inference, they also declare the probable nature of the organic matter now present. . . . . Whether or no the analyst should form an unfavourable opinion of the water from the amount of nitrates must depend upon the proportion of organic matter actually present, and on his confidence in the efficiency and uniform action of the purifying process."

As the basis of his determination of "previous sewage contamination" Frankland takes the sum of the nitrogen present as ammoniacal salts, nitrites, and nitrates, diminished by an allowance for the average amounts of these substances in rain-water; he therefore treats the significance of the ammonia as the same with that of the nitrites and nitrates, as evidence merely of the past presence of nitrogenous organic matter, of which a part *may* remain.

Griess has expressed a strong opinion§ as to to the sanitary importance of detecting nitrates, and the unfitness of water for drinking purposes when containing them.

Ekin|| attaches very great importance to the presence of nitrates and nitrites. Thus he says :

"Waters which have undoubtedly given rise to typhoid fever have been found by the writer over and over again not to contain more than 0·05 part of albumenoid ammonia in 1,000,000, and which, notwithstanding their containing a large excess of nitrates, have been passed by analysts of undoubted ability as being fit for drinking purposes. The attention of the writer was particularly drawn to this in the case of a district where typhoid fever was hardly ever absent, and where the conditions were such as pointed exclusively to water as being the aggravating cause. . . . Samples were taken when the pollution was evident, and analysed. Two only were found to contain an excess of albumenoid ammonia, but all contained a large excess of nitrates. . . . The significance of an excess of nitrates has already been sufficiently dwelt upon, and we have seen that both upon *a priori* grounds and as the result of actual experience, their presence in abnormal quantity is objectionable. . . . When the amount [of nitrates] exceeds 0·5 or 0·6 part [per 100,000], it points significantly to dangerous pollution; . . . nitrogen as nitrites should be invariably absent from a good water. . . . This view of the importance to be attached to an abnormal quantity of nitrates has been formed in spite of a considerable predisposition to a contrary opinion, and has been literally forced upon the writer again and again by the investigation of cases which really leave no doubt in the matter."

(To be continued.)

* Chemical News, September 3, 1869; 113.
† Chemical News, June 25, 1869; 305.
‡ "Water Analysis for Sanitary Purposes"; 27.
§ *Ann. d. Chem. u. Rharm.* cliv; 336.
|| "Potable Water," 2d ed., Lond., 1880; pp. 15, 16, 22, 25, 26, 27, 28, &c.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Journal de Pharmacie et de Chimie. July, 1882.

Researches on the Absorption of Gases by Platinum.—M. Berthelot.—Already noticed.

Report of M. Dumas on the Memoir concerning Albumenoid Matters presented by M. Béchamp to the Academy of Sciences.—From the *Comptes Rendus*.

Action of Oxygenated Water on Organic Matters and Fermentations.—MM. Paul Bert and P. Regnard.—Already noticed.

Phosphorescence and Oxidation of Phosphorus.—Isidore Corne.—The evaporation of phosphorus is the principal cause of phosphorescence, and not oxygen. Phosphorus is not attacked directly by common oxygen, and its oxidation is consecutive on its evaporation. This evaporation produces electricity, which ozonises the oxygen; in this state it attacks the phosphorus.

Determination of the Nitrogenised Matters of Urine from a Hydrological Point of View.—Dr. H. Byasson.—The author proposes to remove from a known volume of urine all the nitrogenous organic substances other than urea, by means of a solution of potassium permanganate. In the urine thus treated he determines the urea by means of sodium hypobromite, the nitrogen liberated belonging entirely to this substance. He then precipitates a known volume of urine with mercuric nitrate, and in the filtrate he determines the ternary matters by means of permanganate. The total quantity of solution of permanganate oxidising a known volume of urine being known, and also that which acts upon the ternary matters, the difference gives the nitrogenous matters other than urea. The barytic precipitate of a known volume of urine is treated with permanganate. The uric acid present is oxidised, and the proportion of permanganate employed gives the quantity of uric acid contained in the urine.

On Yolk of Egg.—P. Carles.—The author speaks of the adulteration of the yolks of eggs in their non-alimentary applications.

Presence and Determination of Copper in Bread.—J. Van der Berghe.—The author being struck with the constancy of the proportion of copper found in bread, was led to make an examination of wheat. In a million parts of this grain he found 9·24 of metallic copper, whilst oats contained 10·8 parts in the same quantity. He had previously ascertained the purity of his reagents, and the gas-burners employed were specially constructed of iron. The capsule (porcelain) was supported on a platinum triangle.

New Reagent for Sulphur and Nitro-benzol.—M. Brunner.—The author mixes the substance under examination with strong potassa lye, and adds a few drops of nitro-benzol and alcohol, and allows the mixture to stand at the common temperature. After some time, if sulphur or alkaline sulphides are present, there appears a red colouration, from the reduction of nitro-benzol. The inverse reaction can be used for the detection of nitro-benzol.

Revue Universelle des Mines, de la Metallurgie, &c., No. 2, March and April, 1882.

Procedures of MM. A. Classen and A. von Reiss for the Electrolytic Separation and Determination of Metals.—V. Francken.—This paper will be inserted at length.

Method for Purifying Arseniferous Copper.—J. Garnier.—From the *Comptes Rendus.*

The Magnesia Industry.— T. Schlœsing.—Taken from the *Comptes Rendus.*

Experimental Researches on the Decomposition of Potassium Picrate.—MM. Sarrau and Vieille.—From the *Comptes Rendus.*

Cosmos Les Mondes.
No. 10, July 8, 1882.

The Sanitary Properties of Iron.—The author points out that certain wines, and especially those of Bordeaux, hold in solution a larger proportion of iron than most so-called chalybeate waters.

No. 11, July 15, 1882.

Dinitro-quinine Mono-hydrate.— F. Renni.— On treating quinine sulphate with a mixture of concentrated nitric and sulphuric acid and precipitating with ammonia a yellowish brown body is obtained, corresponding to the formula $(C_{20}H_{22}NO)_2N_2O_2,H_2O$. This new body does not produce the reactions of quinine with chlorine water and ammonia.

No, 12, July 22, 1882.

Isomorphism.—W. Spring.—The author has observed that all alums expand equally between 0° and 60°. This result leads him to think that equal expansion is the essential characteristic of isomorphism.

Malaria in the District of Rome.—Prof. Tucci, of Veletri, finds the cause of the superior sanitary condition of the Agro Romano in antiquity to the system of deep drainage practised by the Romans, their sewers being often at a level of 15 metres below the surface. The superficial drainage of the present day he thinks scarcely more salubrious than the stagnation of the ground waters, owing to the combined action of the water and the atmosphere upon the tufa which lies below the surface soil.

Colouring-Matter of Urines.—Dr. E. Neusser.—The deep red colour of the urine in tuberculosis, fatty degeneration of the heart, and *morbus Brightii*, is traced to hæmato-porphyrine, spectroscopically identical with oxy-hæmo-globine.

No. 13, July 29, 1882.

An Isomeric Modification of the Ferric Hydrate belonging to the Series *a*.—Dr. D. Tommasi.—The compound in question, which the author names *a b*, is obtained by adding to 200 c.c. distilled water 5 c.c. of liquid ferric chloride containing 23·17 per cent Fe_2Cl_3, and adding to the solution 1 grm. magnesium. The ferric hydrate precipitated is dissolved in glacial acetic acid. The solution is precipitated by sulphuric acid, and the precipitate is insoluble in acetic, nitric, and hydrochloric acids, and only dissolves in a large excess of sulphuric acid.

Electro-metallurgic Process of MM. Blas and Miest.—The authors have established the novel fact that if in electrolysis we replace the metal of the anode by sulphuretted ores in a state of compression, the latter may serve themselves as anodes. Further, if we place such anodes in a bath of a suitable electrolytic salt, of the same metallic base as the metal of the ore, and let the electric current act in the bath, the result is that all the sulphur of the ore is precipitated upon the anode, and falls from thence to the bottom of the bath. In the meantime there is formed upon the cathode a deposit or precipitate of metal liberated from the salt, which forms the electrolytic bath. On the other hand, the acid of the bath, in proportion as it is set free, appropriates an equivalent proportion of the metal contained in the ore placed at the anode. In this manner the neutral electrolytic bath is re-constituted without ceasing and serves indefinitely.

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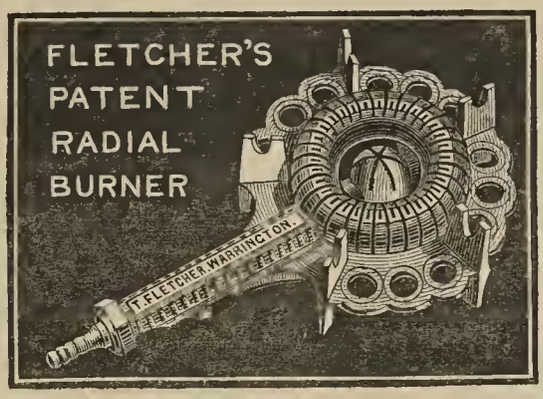

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THE CHEMICAL NEWS.

VOL. XLVI. No. 1188.

ADDRESS TO THE MATHEMATICAL AND PHYSICAL SCIENCE SECTION OF THE BRITISH ASSOCIATION.

By Right Hon. LORD RAYLEIGH, M.A., F.R.S., F.R.A.S.

IN common with some of my predecessors in this chair, I recognise that probably the most useful form which a presidential address could take, would be a summary of the progress of physics, or of some important branch of physics, during recent years. But the difficulties of such a task are considerable, and I do not feel myself equal to grappling with them. The few remarks which I have to offer are of a general, I fear it may be thought of a commonplace, character. All I can hope is that they may have the effect of leading us into a frame of mind suitable for the work that lies before us.

The diversity of the subjects which come under our notice in this section, as well as of the methods by which alone they can be adequately dealt with, although a sign of the importance of our work, is a source of considerable difficulty in the conduct of it. From the almost inevitable specialisation of modern science, it has come about that much that is familiar to one member of our section is unintelligible to another, and that details whose importance is obvious to the one fail altogether to rouse any interest in the mind of the other. I must appeal to the authors of papers to bear this difficulty in mind, and to confine within moderate limits their discussion of points of less general interest.

Even within the limits of those departments whose foundation is evidently experimental, there is room, and indeed necessity, for great variety of treatment. One class of investigators relies mainly upon reiterated appeals to experiment to resolve the questions which appear still to be open, while another prefers, with Thomas Young, to base its decisions as far as possible upon deductions from experiments already made by others. It is scarcely necessary to say that in the present state of science both methods are indispensable. Even where we may fairly suppose that the fundamental principles are well established, careful and often troublesome work is necessary to determine with accuracy the constants which enter into the expression of natural laws. In many cases the accuracy desirable, even from a practical point of view, is hard to attain. In many others, where the interest is mainly theoretical, we cannot afford to neglect the confirmations which our views may derive from the comparison of measurements made in different fields and in face of different experimental difficulties. Examples of the interdependence of measurements apparently distinct will occur to every physicist. I may mention the absolute determinations of electrical resistance, and of the amounts of heat developed from electrical and mechanical work, any two of which involve also the third, and the relation of the velocity of sound to the mechanical and thermal properties of air.

Where a measurement is isolated, and not likely to lead to the solution of any open question, it is doubtless possible to spend upon it time and attention that might with advantage be otherwise bestowed. In such a case we may properly be satisfied for a time with work of a less severe and accurate character, knowing that with the progress of knowledge the way is sure to be smoothed both by a better appreciation of the difficulties involved, and by the invention of improved experimental appliances. I hope I shall not be misunderstood as underrating the importance of great accuracy in its proper place if I express the opinion that the desire for it has sometimes had a prejudicial effect. In cases where a rough result would have sufficed for all immediate purposes, no measurement at all has been attempted, because the circumstances rendered it unlikely that a high standard of precision could be attained. Whether our aim be more or less ambitious, it is important to recognise the limitations to which our methods are necessarily subject, and as far as possible to estimate the extent to which our results are uncertain. The comparison of estimates of uncertainty made before and after the execution of a set of measurements may sometimes be humiliating, but it is always instructive.

Even when our results show no greater discrepancies than we were originally prepared for, it is well to err on the side of modesty in estimating their trustworthiness. The history of science teaches only too plainly the lesson that no single method is absolutely to be relied upon, that sources of error lurk where they are least expected, and that they may escape the notice of the most experienced and conscientious worker. It is only by the concurrence of evidence of various kinds and from various sources that practical certainty may at last be attained, and complete confidence justified. Perhaps I may be allowed to illustrate my meaning by reference to a subject which has engaged a good deal of my attention for the last two years—the absolute measurement of electrical resistance. The unit commonly employed in this country is founded upon experiments made about twenty years ago by a distinguished committee of this Association, and was intended to represent an absolute resistance of 10^9. C.G.S., *i.e.*, one ohm. The method emplyed by the committee at the recommendation of Sir W. Thomson (it had been originally proposed by Weber) consisted in observing the deflection from the magnetic meridian of a needle suspended at the centre of a coil of insulated wire, which formed a closed circuit, and was made to revolve with uniform and known speed about a vertical axis. From the speed and deflection in combination with the mean radius of the coil and the number of its turns, the absolute resistance of the coil, and thence of any other standard, can be determined.

About ten years later Kohlrausch attacked the problem by another method, which it would take too long to explain, and arrived at the result that the B.A. unit was equal to 1·02 ohms—about two per cent too large. Rowland, in America, by a comparison between the steady battery current flowing in a primary coil with the transient current developed in a secondary coil when the primary current is reversed, found that the B.A. unit was 0·991 ohm. Lorentz, using a different method again, found 0·980, while H. Weber, from distinct experiments, arrived at the conclusion that the B.A. unit was correct. It will be seen that the results obtained by these highly competent observers range over about four per cent. Two new determinations have lately been made in the Cavendish laboratory at Cambridge, one by myself with the method of the revolving coil, and another by Mr. Glazebrook, who used a modification of the method followed by Rowland, with the result that the B.A. unit is 0·986 ohm. I am now engaged upon a third determination, using a method which is a modification of that of Lorentz.

In another important part of the field of experimental science, where the subject-matter is ill understood, and the work is qualitative rather than quantitative, success depends more directly upon sagacity and genius. It must be admitted that much labour spent in this kind of work is ill-directed. Bulky records of crude and uninterpreted observations are not science, nor even in many cases the raw material out of which science will be constructed. The door of experiment stands always open; and when the question is ripe, and the man is found, he will nine times out of ten find it necessary to go through the work again. Observations made by the way, and under favourable conditions, may often give rise to valuable suggestions, but these must be tested by experiment, in which the conditions are simplified to the utmost, before they can lay claim to acceptance.

When an unexpected effect is observed, the question will arise whether or not an explanation can be found upon admitted principles. Sometimes the answer can be quickly given; but more often it will happen that an assertion of what *ought* to have been expected can only be made as the result of an elaborate discussion of the circumstances of the case, and this discussion must generally be mathematical in its spirit, if not in its form. In repeating, at the beginning of the century, the well-known experiment of the inaudibility of a bell rung *in vacuo*, Leslie made the interesting observation that the presence of hydrogen was inimical to the production of sound, so that not merely was the sound less in hydrogen than in air of equal pressure, but that the actual addition of hydrogen to rarefied air caused a diminution in the intensity of sound. How is this remarkable fact to be explained? Does it prove that, as Herschel was inclined to think, a mixture of gases of widely different densities differs in its acoustical properties from a single gas? These questions could scarcely be answered satisfactorily but by a mathematical investigation of the process by which vibrations are communicated from a vibrating solid body to the surrounding gas. Such an investigation, founded exclusively upon principles well established before the date of Leslie's observation, was undertaken years afterwards by Stokes, who proved that what Leslie observed was exactly what ought to have been expected. The addition of hydrogen to attenuated air increases the wave-length of vibrations of given pitch, and consequently the facility with which the gas can pass round the edge of the bell from the advancing to the retreating face, and thus escape those rarefactions and condensations which are essential to the formation of a complete sound wave. There remains no reason for supposing that the phenomenon depends upon any other elements than the density and pressure of the gaseous atmosphere, and a direct trial, *e.g.*, a comparison between air and a mixture of carbonic anhydride and hydrogen of like density, is almost superfluous.

Examples such as this, which might be multiplied *ad libitum*, show how difficult it often is for an experimenter rightly to interpret his results without the aid of mathematics. It is eminently desirable that the experimenter himself should be in a position to make the calculations, to which his work gives occasion, and from which in return he would often receive valuable hints for further experiment. I should like to see a course of mathematical instruction arranged with especial reference to physics, within which those whose bent was plainly towards experiment might, more or less completely, confine themselves. Probably a year spent judiciously on such a course would do more to qualify the student for actual work than two or three years of the usual mathematical curriculum. On the other side, it must be remembered that the human mind is limited, and that few can carry the weight of a complete mathematical armament without some repression of their energies in other directions. With many of us difficulty of remembering, if not want of time for acquiring, would impose an early limit. Here, as elsewhere, the natural advantages of a division of labour will assert themselves. Innate dexterity and facility in contrivance, backed by unflinching perseverance, may often conduct to successful discovery or invention a man who has little taste for speculation; and on the other hand the mathematician, endowed with genius and insight, may find a sufficient field for his energies in interpreting and systematising the work of others.

The different habits of mind of the two schools of physicists sometimes lead them to the adoption of antagonistic views on doubtful and difficult questions. The tendency of the purely experimental school is to rely almost exclusively upon direct evidence, even when it is obviously imperfect, and to disregard arguments which they stigmatise as theoretical. The tendency of the mathematician is to overrate the solidity of his theoretical structures, and to forget the narrowness of the experimental foundation upon which many of them rest.

By direct observation, one of the most experienced and successful experimenters of the last generation convinced himself that light of definite refrangibility was capable of further analysis by absorption. It has happened to myself, in the course of measurements of the absorbing power of various media for the different rays of the spectrum, to come across appearances at first sight strongly confirmatory of Brewster's views, and I can therefore understand the persistency with which he retained his opinion. But the possibility of further analysis of light of definite refrangibility (except by polarisation) is almost irreconcilable with the wave theory, which on the strongest grounds had been already accepted by most of Brewster's contemporaries; and in consequence his results, though urgently pressed, failed to convince the scientific world. Further experiment has fully justified this scepticism, and in the hands of Airy, Helmholtz, and others, has shown that the phenomena by which Brewster was misled can be explained by the unrecognised intrusion of diffused light. The anomalies disappear when sufficient precaution is taken that the refrangibility of the light observed shall really be definite.

On similar grounds undulationists early arrived at the conviction that physically light and invisible radiant heat are both vibrations of the same kind, differing merely in wave-length; but this view appears to have been accepted slowly, and almost reluctantly, by the experimental school.

When the facts which appear to conflict with theory are well defined and lend themselves easily to experiment and repetition, there ought to be no great delay at arriving at a judgment. Either the theory is upset, or the observations, if not altogether faulty, are found susceptible of another interpretation. The difficulty is greatest when the necessary conditions are uncertain, and their fulfilment rare and uncontrollable. In many such cases an attitude of reserve, in expectation of further evidence, is the only wise one. Premature judgments err perhaps as much on one side as on the other. Certainly in the past many extraordinary observations have met with an excessive incredulity. I may instance the fire-balls which sometimes occur during violent thunderstorms. When the telephone was first invented, the early reports of its performances were discredited by many on quite insufficient grounds.

It would be interesting, but too difficult and delicate a task, to enumerate and examine the various important questions which remain still undecided from the opposition of direct and indirect evidence. Merely as illustrations I will mention one or two in which I happen to have been interested. It has been sought to remedy the inconvenience caused by excessive reverberation of sound in cathedrals and other large unfurnished buildings by stretching wires overhead from one wall to another. In some cases no difference has been perceived, but in others it is thought that advantage has been gained. From a theoretical point of view it is difficult to believe that the wires could be of service. It is known that the vibrations of a wire do not communicate themselves in any appreciable degree directly to the air, but require the intervention of a sounding-board, from which we may infer that vibrations in the air would not readily communicate themselves to stretched wires. It seems more likely that the advantage supposed to have been gained in a few cases is imaginary than that the wires should really have played the part attributed to them.

The other subject on which, though with diffidence, I should like to make a remark or two, is that of Prout's law, according to which the atomic weights of the elements, or at any rate of many of them, stand in simple relation to that of hydrogen. Some chemists have reprobated strongly the importation of *à priori* views into the consideration of the question, and maintain that the only numbers worthy of recognition are the immediate results of experiment. Others, more impressed by the argument that the close approximations to simple numbers cannot be merely fortuitous, and more alive to the inevitable imper-

fections of our measurements, consider that the experimental evidence against the simple numbers is of a very slender character, balanced, if not outweighed, by the *à priori* argument in favour of simplicity. The subject is eminently one for further experiment; and as it is now engaging the attention of chemists, we may look forward to the settlement of the question by the present generation. The time has perhaps come when a redetermination of the densities of the principal gases may be desirable—an undertaking for which I have made some preparations.

If there is any truth in the views that I have been endeavouring to impress, our meetings in this section are amply justified. If the progress of science demands the comparison of evidence drawn from different sources, and fully appreciated only by minds of different order, what may we not gain from the opportunities here given for public discussion, and, perhaps more valuable still, private interchange of opinion? Let us endeavour, one and all, to turn them to the best account.

ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.

By Prof. G. D. LIVEING, M.A., F.R.S., F.C.S.,
President of the Section.

If I were asked in what direction chemical science had of late been making the most important advances, I should reply that it was in the attempt to place the dynamics of chemistry on a satisfactory basis, to render an account of the various phenomena of chemical action on the same mechanical principles as are acknowledged to be true in other branches of physics. I cannot say that chemistry can yet be reckoned amongst what are called the exact sciences, that the result of bringing together given matters under given circumstances can yet be deduced in more than a few special cases by mere mathematical processes from mechanical principles, but that some noteworthy advances have in recent years been made, which seem to bring such a solution of chemical problems more nearly within our reach.

To show how large a gap in our ideas of chemical dynamics has been bridged over within the last quarter of a century, I will quote the words of one of the largest minded philosophers of his time, who was one of the earliest promoters of this Association, and its President in 1841: Whewell, in a new and much altered edition of his "Philosophy of the Inductive Sciences," published in 1858, says:—"Since Newton's time the use of the word *attraction*, as expressing the cause of the union of the chemical elements of bodies, has been familiarly continued, and has no doubt been accompanied in the minds of many persons with an obscure notion that chemical attraction is in some way a kind of mechanical attraction of the particles of bodies. Yet the doctrine that *chemical* "attraction" and *mechanical* attraction are forces of the same kind has never, so far as I am aware, been worked out into a system of chemical theory; nor even applied with any distinctness as an explanation of any particular chemical phenomena. Any such attempt, indeed, could only tend to bring more clearly into view the entire inadequacy of such a mode of explanation. For the leading phenomena of chemistry are all of such a nature that no mechanical combination can serve to express them without an immense accumulation of additional hypotheses." ("History of Scientific Ideas," ii., 13.) And further on he says:—"We must consider the power which produces chemical combination as a peculiar principle, a special relation of the elements not rightly expressed in mathematical terms." (*Ibid.*, p. 14.)

The influence by which our ideas have gone round so as to be now the very opposite of those of the illustrious thinker whom I have just quoted, so that we should ridicule the thought of looking for an explanation of chemical action on any but mechanical principles, is undoubtedly the progress which has been made in other branches of molecular physics. The indestructibility of matter has long been a formula familiar to chemists, but that the conservation of energy should be as universally true, even in regard to chemical actions, has only in recent years been fully recognised. This is certainly no new principle, it was developed mathematically generations ago; but the realisation that it is anything more than an abstraction, that it is the keynote of every rational explanation of physical phenomena, has been the foundation of recent progress in physical science; and if all energy be one, there can be but one code of dynamical laws which must apply to chemistry as well as to all other branches of physics. The development of the mechanical theory of heat, and of the molecular theories which have grown up in consequence of it, have done much to set our minds free from preconceived notions, and to induce us to build chemical theories on something more than unverified conjectures.

But how far can we say that mechanical principles are actually recognised as the true basis of rational chemistry? So far as I know no chemist denies that it is so, and yet how little do our text-books, even the most recent and the most highly reputed, show the predominance of this idea! How very small a portion of such books is taken up with it, how much seems utterly to ignore it or to be couched in language antagonistic to it! We still find chemical combinations described as if they were statical phenomena, and expressions used which imply that two perfectly elastic bodies can, by their mutual action alone, bring each other into fixed relative positions. We still find change of valency described as a suppression of "bonds of affinity," as if a suppression of forces were the usual course of nature, or as if it were possible that the same two forces, acting at the same place and in the same direction, should at one time neutralise one another, and at another time not neutralise one another. We still find saturated compounds spoken of as if the stability of a compound were independent of circumstances, and chemical combination no function of temperature and pressure. Beginners are sometimes helped by the invention of intermediate reactions in explanation of final results, without any reference to the dynamical conditions of the problem, without any consideration whether the fancied intermediate reactions imply a winding-up or a running-down of energy. In fact our long familiar chemical equations represent only the conservation of matter, and to keep always in mind the mechanical conditions of a reaction is as difficult to some of us as it is to think in a foreigh language. Moreover, we still find in many of our text-books the old statical notion of chemical combination stereotyed in pictures of molecules. I do not, of course, mean to accuse the distinguished inventors of graphic formulæ of meaning to depict molecules, for I believe that they would agree with me in thinking that these diagrams do not any more nearly represent actual molecules than they represent the solar system; but unfortunately we cannot prevent beginners from regarding them as pictures, and moulding their ideas upon them. They present something easily grasped by the infant mind, and schoolmasters are fond of them; but only those who have each year to combat a fresh crop of misconceptions, and false mechanical notions engendered by them, can be aware how much they hinder, I won't say the advance, but the spread of real chemical science. If it be true that the illustrations of an artist like the late Hablot Browne give to our conceptions of the characters of a story a more definite and permanent, though perhaps a much modified form of what the author of the story intended to portray, it is equally true that the illustrations by which some, even great names amongst us, have tried to make us fancy that we had a true conception of some natural process, have become so fixed in our minds as to prevent us realising the true meaning of nature.

What, then, is the progress which I think has been made in physical chemistry? In the first place, notwithstanding the slowness with which new ideas replace old familiar images, the molecular theories developed by Clausius, Clerk-Maxwell, and Boltzmann, and by Sir W. Thomson, have been long enough before the world to have greatly loosened the hold upon our minds of many old notions. The rigid, unbreakable, impenetrable atoms of the Epicurean philosophy, made familiar to us by Lucretius, always presented difficulties which were only perhaps exceeded by those of the elastic atmospheres with which modern philosophers fancied them to be surrounded; but now the vortex theory, whether we think it probable or not, at least gives us a standing ground for the assertion that the supposed impenetrability of matter, and the curious compound of nucleus and atmosphere which had been invented to account for elasticity, are not necessary assumptions.

The kinetic theory of gases has analysed for us the different motions of the molecules in a mass of matter, and has facilitated the conception of the part which heat plays in chemical action. Hence we have had of late several attempts to reduce to a form susceptible of mathematical calculation the problems of chemistry. Most of these attempts have proceeded on the well-known mechanical principle that the change of *vis viva* of a system, in passing from an initial to a final configuration, is independent of the intermediate stages through which it may have passed provided the external conditions are unaltered; and on the principle of the dissipation of energy, that is to say, on the condition that the state of the system, if it be a stable one, must be such that the energy run down in reaching it is a maximum. These principles have been applied successfully to the solution of some particular cases of the equilibrium between a mixture of chemicals by Willard Gibbs, Berthelot, and others. By the first-mentioned principle all consideration of the intermediate stages by which the final result is reached is avoided. Quite recently Lemoinne has attacked the same problem on another principle. His principle is that of an equilibrium of antagonistic reactions in a mixture of materials, a mobile equilibrium, such as we are now familiar with, dependent on compensating effects; but he does not seem able to solve the problem in any great number of cases. In fact, the difficulty does not now lie so much in expressing mathematically the conditions of the problem, as in the defect of knowledge which depends upon experiment. And it is just in this that I think the outlook most hopeful. In some cases the patient work of weighing, measuring, and comparing, which is necessary to make our theoretic speculations of any substantial value, has been already done for us. The publication, three years since, of Berthelot's "Essay on Chemical Mechanics," has given us, in a collected form, a large quantity of data of the first importance, and now I am glad to say that the long labours of another worker in the same field, Thomsen, of Copenhagen, are in course of publication in a handy form. I think these two investigators have done more than anyone else of late years towards making it possible to give chemistry the rank of an exact science. But besides the data which they have supplied to us, there are others which are yet wanting. For instance, almost every equation of chemical equilibrium involves an expression depending on the specific heat of the materials. At present we do not know enough of the law of specific heats to be able to give in most cases a probable value to these expressions, but these and other data of the kind do not seem out of our reach, and we may hope that the same ingenuity and patience which has gained for us so much firm ground in thermal chemistry will extend it to the uncertain spots where we have yet no solid foundation.

Further, the laws of dissociation, so ably investigated by Deville, have taught us that the force called chemical affinity, by which we suppose the atoms of unlike matters are held together in a compound molecule, follows precisely the same laws as the force of cohesion by which particles of a similar kind are united in molecules. We have long known that the molecules of sulphur vapour are broken up into simpler molecules by elevation of temperature and condense again when the temperature is reduced. Other elementary substances behave in a similar way. We have within the last two or three years learnt that iodine is in part dissociated by a high temperature from molecules consisting of two chemical atoms into molecules consisting of only one such atom, and the same is true of chlorine and bromine. That some such change must occur in iodine was inferred as long ago as 1864 by the younger Mitscherlich. He argued that iodine is a compound body from the fact that it shows two spectra, one similar in character to those of metallic oxides and the other similar to the spectra of metals, and from the analogy in the behaviour of iodine to a metallic oxide in giving the one spectrum at one temperature and the other at a higher temperature: "from this," he says, "it would follow that iodine at ordinary temperatures and iodine at the temperature of a hydrogen flame must be considered as two different compounds, because the spectrum of iodine formed at ordinary temperatures" (that is, the absorption-spectrum of iodine vapour) "is different from that produced in a hydrogen flame." Also, "that bromine, though it gives no flame spectrum, gives one spectrum by absorption and another by the electric spark, and must therefore in its ordinary state be regarded as a compound." Also, that "the spectra formed by the flames of selenium, tellurium, and phosphorus, and those of sulphur and nitrogen given by feeble electric discharges, all have the character of the iodine flame spectrum, and these metalloids would therefore, if the above-expressed supposition with regard to iodine be confirmed, also be compound bodies." (*Phil. Mag.*, 1864, p. 188.) Since the paper from which the foregoing extract is taken was published, not only the metalloids but many metals have been found to give complicated spectra at one temperature and much simpler spectra at higher temperatures. Such are the channelled spectra of sodium and potassium, first described by Roscoe and Schuster, the channelled spectra of silver, bismuth, and other metals described by Lockyer and Roberts, and the ultra-violet channelled spectrum of tin recently photographed by Dewar and myself. Mitscherlich's hypothesis gives us a rational explanation of such multiple spectra produced by the same substance, and it has been accepted, in one form or another, by all spectroscopists since he wrote. Nevertheless, the existence of multiple spectra cannot be taken as a proof of allotropic modification unless the possibility of a chemical combination be excluded. The channelled spectrum which magnesium gives in hydrogen was mistaken by more than one observer for that of some modification of the simple metal, until it was shown that magnesium in nitrogen or other gases does not give it if no hydrogen is present, and that its persistence in hydrogen at high temperatures depends, as does the permanence of chemical combinations, on the pressure of the gas. If, however, homogeneous molecules are dissociated by heat, so also are heterogeneous molecules, formed, as we say, by chemical combination, split up by elevation of temperature, to unite again on cooling, or when the pressure is increased within certain limits. Nor is there any essential difference in character between a chemical compound and an element beyond that of facility of decomposition. If we could not so easily resolve them into their constituents, and were to disregard the difference of their spectra, no one would suppose ammonia to be differently constituted from potassium, or cyanogen from chlorine. Indeed, chemists have long been in the habit of considering the union of two atoms in a molecule of ordinary hydrogen or chlorine as a species of chemical combination: but when we find that the combinations of particles of the same kind are as definite as those of particles of different kinds, and that they are both subject to precisely the same mechanical laws, we

are hardly justified in regarding the forces by which they are produced as essentially different. To get rid of a gratuitous hypothesis in chemistry must be a great gain.

But it may be asked, why stop here? Why may not the chemical elements be further broken up by still higher temperatures? *A priori* and from analogy such a supposition is extremely probable. The notion that there is but one elementary kind of matter is at least as old as Thales, and underlies Prout's hypothesis that the atomic weights of our elements are all multiples of that of hydrogen. This famous hypothesis has gone up and down in the scale of credibility many times during the present century. About seventeen years ago the publication of Stas's new determinations of combining weights, carried out on a scale never before attempted, and with all the refinements which the growth of our knowledge could suggest, was thought to have given it its deathblow. But a reaction has set in since that time. The periodic recurrence of the properties of elements with regular additions to the atomic weights, like octaves in a musical scale, put forcibly before us by Mendelejeff, makes it difficult not to think that there is a simple relation between the atomic weights, though there may be causes producing slight perturbations of such a relation. Quite recently a fresh revision of the combining weights has been made on the other side of the Atlantic by Professor F. W. Clarke. He has collected all the determinations made by different observers, and after rejecting such as from defective methods were untrustworthy, has applied to the remainder such corrections as newer experiences have suggested, and then deduced from the corrected numbers the most probable values by the methods of the theory of errors. Professor Clarke has done a piece of work of the highest utility, for which chemists must be grateful; nevertheless, he has not carried the revision so far as it might be carried. He has, to begin with, rightly separated the several sets of observations, and deduced the most probable number from each set by itself, but in combining the various sets for the final determination of the numbers adopted, he has treated the results obtained by different methods, as if they were a set of observations all presumably of equal value, so that the most probable numbers could be deduced by the method of least squares. He has not attempted any discussion of the different methods with a view to an estimate of the relative values of the results obtained by them, nor made any difference between the values of the figures deduced from operations on the large scale employed by Stas and those arrived at on the small scale of other observers. Any sort of handicapping of methods is no doubt a very difficult and delicate operation, and requires more than the judgment of an Admiral Rous, but without it the question whether the numbers adopted are the best obtainable will always be an open one. It is, however, a very noteworthy fact, that in almost every case the numbers deduced from Stas's experiments, taken by themselves, coincide very closely indeed with the most probable numbers derived by the method of least squares from the whole of the recorded estimates. On the whole, Professor Clarke concludes that Prout's hypothesis, as modified by Dumas, is still an open question; that is to say, his final numbers differ from whole multiples of a common unit by quantities which lie within the limits of error of observation and experiment.

Let us turn again to the evidence afforded by our most powerful instrument for inspecting the inner constitution of matter, the spectroscope. A few years ago Mr. Lockyer supposed that the coincidence of rays emitted by different chemical elements, particularly when those rays were developed in the spark of a powerful induction coil and in the high temperatures of the sun and stars, gave evidence of a common element in the composition of the metals which produced the coincident rays. Such an argument could not be drawn from the coincidences unless they were exact, and the identity of the lines could only be tested by means of spectroscopes of great resolving power. By the use of the well-known Rutherford gratings, Young in America had found that most of the solar lines which had been ascribed to two metals were in reality double, and Dewar and I, working on the terrestrial elements in the electric arc, had found the actual coincidences to be very few indeed. These observations, even with Rutherford gratings, were delicate enough; but quite recently M. Fievez, of the Brussels Observatory, has brought to bear on this question a spectroscope of unexampled power. By combining two of the Astronomer Royal's highly dispersive half-prisms with a Rutherford grating of 17,296 lines to the inch, he has obtained a dispersion quadruple that of Thollon's combination of prisms. Bringing this to bear on the sun he has mapped the solar spectrum from a little below C to somewhere above F, on a scale one-third greater than that of Vogel's map, and has not only confirmed the work of Young, Dewar, and myself, but has resolved some lines which were not divisible by such dispersive power as we had at command. This result cannot fail to shake our belief, if we had any, in the existence of any common constituent of the chemical elements; but it does not touch the evidence which the spectroscope affords us, that many of our elements, in the state in which we know them, must have a very complex molecular structure. I cannot illustrate this point better than by the spectra of two of our commonest elements, magnesium and iron. We have good reason to think the molecule of magnesium to be as simple as that of any chemical element, and we find its spectrum to be one of the simplest, consisting of a series of triplets which repeat each other in a regular way and are probably harmonically related, and of a comparatively small number of single lines, of which also some may be harmonics. The spectrum of iron, on the other hand, presents thousands of lines distributed irregularly through the whole length, not only of the visible, but of the ultra-violet region. Make what allowance you please for unknown harmonic relations, and for lines which are not reversible and may not be directly due to vibrations of the molecules, we still have a number of immense vibrations, so that we can hardly conceive any single molecule to be capable of all of them, and are almost driven to ascribe them to a mixture of differing molecules, though we have as yet no independent evidence of this, and no satisfactory proof that any of this mixture are of the same kind as occur in other elements.

M. Fievez's combination is a great advance in resolving power, but Professor Rowland, of the Johns Hopkins University, promises us gratings not only exceeding Rutherford's both in dimensions and accuracy of ruling, but ruled upon curved surfaces so as to dispense with the use of telescopes and avoid all variations in focussing the different orders of spectra. His instruments, if they come up to the promise he holds out, will enable us to solve many questions which are difficult to answer with our present appliances.

But to return to the chemical elements: the spectroscope has in the last few years revealed to us several new metals. I will not venture to say how many, for when several new metals more or less closely allied are discovered at the same time, the process of sifting out their differences is necessarily a slow one. We cannot tell yet whether any of them are to fill gaps in Mendelejeff's table, and so add strength to the conviction that there is a natural relation between the atomic weights and the chemical characters of our elementary substances, or whether they will add to the embarrassment in which we already find ourselves with regard to the relations of the cerium group of metals; whether we may welcome them as the supporters of order, or deprecate their coming as authors of confusion. Granting that the chemical characters of an element are connected with its atomic weight, we have, however, no right to assume them to be dependent on that factor alone. Why may there not be elements which, while they differ as little in atomic weight as do nickel and cobalt, are, on the other hand, so

similar to one another in all characters that their chemical separation is a matter of the greatest difficulty, and their difference only distinguishable by the spectroscope? The spectra may be thought to suggest so much, and how shall we decide the question? At any rate the complications of the spectroscopic problem can only be unravelled by the united efforts of the chemists and physicists, and by the exercise of extreme caution.

I cannot dismiss the subject of chemical dynamics without alluding to the ingenious theory by which the President of the Association has proposed to account for the conservation of solar energy. He supposes planetary space to be pervaded by an atmosphere which, except where it is condensed by the attraction of the sun and planets, is in a highly attenuated state. The sun and planets communicate some of their own motion of rotation to the atmosphere condensed about them, and he supposes that in this way an action like that of a blowing fan is set up, by which the equatorial part of the sun's atmosphere acquires such a velocity as to stream out to distances beyond the earth's orbit, while an equal quantity of gas is drawn in at the poles to maintain equilibrium. The gases thus driven to a distance in planetary space will of course be enormously expanded and highly attenuated, and in this state Dr. Siemens thinks that such of them as are compound may be decomposed by absorbing the solar radiation, and thus the kinetic energy of the sun's rays be converted into the potential energy of chemical separation. The separated elements, or partial compounds will in the circulation produced by the fanlike action of the solar rotation be carried back to the polar regions of the sun as fuel to maintain his temperature by condensation and re-combination. I will not discuss the mechanical part of this theory further than to remark that the fanlike action can only be carried on at the expense of the energy of the sun's rotation, which must in consequence be continually diminishing, and must in time become too slow to produce any sensible projection of the atmosphere into distant regions of planetary space. As to the chemical side of the theory, Dr. Siemens supposes the gases which pervade the planetary space to be not only of the same kind as the components of our own atmosphere, which on the kinetic theory of gases must diffuse through that space, but also such gases as are not found in our air, but are found occluded in meteorites which may be supposed to have acquired them in their previous wanderings. Amongst these he specially mentions hydrocarbons which form the self-luminous part of most comets. It is to these gases, together with aqueous vapour and carbonic acid, that he ascribes the principal part in the conservation of solar energy. That compound gases at the extremely low pressure of the planetary space are decomposed by solar radiation is not inconsistent with the laws of dissociation, for it is quite possible that some compounds may be decomposed at ordinary temperatures by mere reduction of pressure, and the radiation absorbed will be the more effective because it will directly affect the vibratory motion within the molecule, and may well produce chemical decomposition before it can, when the free path of the molecules is so much increased by the attenuation of the gas, assume the form of an increased temperature. Dr. Siemens, moreover, adduces a remarkable experiment in confirmation of this supposition. We know, too, the power which our atmosphere, and especially the water vapour in it, has of absorbing the infra-red rays, and that amongst the Fraunhofer lines some of the strongest groups are due to aqueous vapour; and the capital observation made by the spectroscopic observers at the last total eclipse, that the group of lines known as "B," which is one of those produced by aqueous vapour, is greatly strengthened when the sun's light passes by the edge of the moon and so through the lunar atmosphere, may be taken as a confirmation of the theory that gases like our atmosphere are diffused through space and concentrated about the planets. But if it be true that the compounds are decomposed by absorbing the sun's rays, we ought to find in our atmosphere the products of decomposition, we ought to find in it free hydrogen, carbonic oxide, and acetylene or some other hydrocarbons. The hydrogen, from its small specific gravity, would not be concentrated in the lower regions of our atmosphere in the same proportions as the denser gases, but carbonic oxide and hydrocarbons could not fail to be detected in the air if they formed any sensible proportion of the gases in the planetary space. That a large portion of the solar radiation is intercepted before it reaches the earth is no doubt true, for there are not only the dark bands which are increased by our atmosphere and may reasonably be attributed to the action of like gases pervading planetary space, but there is a continuous absorption of the ultra-violet spectrum beyond the line U, and Cornu has found that this absorption is not sensibly affected by our atmosphere, so that the substance, whatever it be that produces it, may be an agent in the process imagined by Dr. Siemens, but cannot be the means of restoring to the sun any portion of his radiant energy which reaches our distance from him.

Dr. Siemens explains the self-luminous character of comets by the theory that the streams of meteoric stones of which they are supposed to consist bring from stellar space hydrocarbon and other gases occluded within them, and that in consequence of the rise of temperature due to the frictional resistance of such a divided mass moving with enormous velocity, aided by attractive condensation, the occluded gases will be driven out and burnt, the flame giving rise to the original light emitted by the nucleus. Now the spectrum of most comets shows only the principal bands of a Bunsen burner, and is therefore adequately explained by the flame of gas containing hydrocarbons such as have been found in meteorites; but Dr. Huggins has observed in the spectrum of more than one comet, not only hydrocarbon, but cyanogen bands; and, although carbon and nitrogen combine readily in the electric arc, a coal-gas flame in air shows no trace of the spectrum of cyanogen, and it would certainly put some strain on our credulity if it were asserted that cyanogen was one of the gases brought ready-formed by meteorites from stellar space. Dewar and I have, however, recently shown that if nitrogen already in combination, as, for instance, ammonia, be brought into a hydrocarbon flame, cyanogen is produced in sufficient amount to give in a photograph (though not so as to be directly visible) the characteristic spectrum of cyanogen as it appears in the comet. It is therefore no longer necessary to make any other supposition to account for the cyanogen bands in the spectra of comets, than that ammonia, or some such compound of nitrogen, is present as well as hydrocarbons in a state of ignition.

Quite recently Dr. Huggins has observed that the principal comet of this year has a spectrum of an entirely different character, but he is not yet able to say to what elements or compounds it is probably due. The notion that comets may bring us news of distant parts of stellar space, towards which our system is driving, where the atmosphere is not like ours—oxygen and nitrogen—but hydrogen and hydrocarbons, may fascinate the fancy, but the laws of occlusion oblige us to think that the meteorites have not merely wandered through an attenuated atmosphere of hydrogen and hydrocarbons, but have cooled in a much denser atmosphere of those substances, which we can only conceive as concentrated by the presence of a star or some large aggregation of matter. They may, perchance, have come from some nebulous mass, for Draper and Huggins tell us that in the great nebula in Orion hydrogen is dense enough and hot enough to show some of its characteristic lines, besides the F line which is seen in other nebulæ, and is the last to disappear by reduction of density. No comet on visiting our system a second time can repeat the exclusion of its occluded gases unless its store has been replenished in the interval, and it will be interesting to see, when Halley's comet next

returns, whether it shines only by reflected light or gives us, like so many others, the banded spectrum of hydrocarbons.

THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.*

By Prof. J. W. MALLET, F.R.S., University of Virginia.

(Continued from p. 92.)

REUBEN HAINES, of Philadelphia, has furnished† the details of some cases in his own experience, which he says are "in partial corroboration of the opinions of Mr. Ekin."

Among the artificially polluted waters of the investigation now reported on, there are a number of samples of such general character as to attach to them the gravest suspicion on sanitary grounds, suspicion corroborated in sundry cases by the biological tests applied to them; in which, nevertheless, nitrates and nitrites are not found; but in these waters we find the quantity of organic matter extraordinarily large, and generally accompanied by very large amounts of ammonia—*e.g.*, Nos. 119, 120, 121 containing water in which the dead body of an animal had been allowed to macerate; Nos. 122, 123, 124 containing much blood from a slaughter-house, and Nos. 137 and 138 containing the dejecta from typhoid-fever patients.

Looking at the results from the natural waters of Classes I. and II., and bearing in mind the conclusions reached by Müller, Schloesing and Müntz, Storer, Warington, and others‡ as to the process of nitrification being due to the presence of an organised ferment or ferments of bacterial character, the idea suggests itself whether the noxious character of waters containing largely of nitrates and nitrites—themselves presumed to be harmless,—and but very little organic matter—which ought to be present, of some sort, to support the "previous contamination" view—*may not be in reality due to the presence of a special nitrifying ferment, itself to be classed among the lower organisms capable of propagating disease.*

4. Two points require to be borne in mind, suggestive of caution in drawing such conclusions as the above in regard to the sanitary in connection with the chemical character of water.

In the first place, the samples examined may possibly have undergone chemical change in the interval from their collection to their reaching the analysts, so that, for example, organic matter may have disappeared or nitrates may have been formed. With the precautions taken to lose as little time as possible, there does not seem much likelihood of such changes having occurred to so serious an extent as to essentially alter the character of the water.

In the second place, with the object which I had in view, of obtaining samples of water capable of producing disease, it was necessary to take what may be called *exaggerated instances* of mischief—well marked or comparatively violent cases of illness—since no others could well be traced with sufficient strength of probability to their supposed cause, and it may very possibly be that the organic impurities present in the waters concerned in such cases are not the same as those which would produce slighter, but in time serious, ill effects. Slighter forms of disease, in reality attributable to drinking-water, may perhaps be numerous, and possibly of various types, but generally the difficulty will be too great of securing, in view of the many factors concerned, any satisfactory evidence as to their cause. The collection of strongly-marked cases only, neglecting slighter ones if such exist, involves to some extent the same fault in principle as the commonly applied test of the death-rate for particular diseases in the discussion of local sanitary conditions: there may be numerous cases of illness, with but few deaths. The same difficulty also is experienced in trying pathological experiments on the lower animals; only strongly marked effects can be noted or satisfactorily connected with their supposed cause.

5. In regard to the comparatively rough determinations of chlorine, the results are, in many of the cases of water from shallow wells, significant enough of contamination by fluid animal excreta. The amounts of chlorine found in specimens Nos. 2, 3, and 4 of water from the deep artesian wells at Charleston, S.C., and in No. 22 from a well near the sea on Staten Island, and Nos. 50 and 51 from a well, and No. 52 from a pond in the neighbourhood of the sea at Newport, R.I., illustrate the need for thought as to the natural source of a water in drawing conclusions in connection with the presence of chlorides. Even in cases in which chlorine has come in with organic matter, the impropriety of too hastily deciding, as is sometimes done, that a small quantity indicates vegetable and a large amount animal contamination, as illustrated by the results for No. 65, containing an infusion of hay or dry herbage,* and for Nos. 87 and 88, containing the alkaline washings from wood pulp at a paper-mill, in contrast with those for Nos. 120 and 121, containing a very foul infusion of the body of a dead animal, and for Nos. 138 and 139, containing morbid animal matter from cases of typhoid and scarlet fever.

Biological Results Contrasted with the Actual Character of the Waters Examined.

The lists of waters marked (independently) by Profesor Martin and Dr. Hartwell as "dangerous" and "suspicious" on the basis of the biological observations are summarised, in connection with the classes represented, in Table XXIII.

TABLE XXIII.—*Biological Classification of Waters.*

		Professor Martin.		Dr. Hartwell.	
Class.	No. in class.	Dangerous.	Suspicious.	Dangerous.	Suspicious.
I. ..	19	—	4	—	7
II. ..	19	—	2	—	1
III. ..	20	2	1	1	3
IV. ..	20	3	3	3	2
V. ..	21	4	5	2	10
VI. ..	21	4	1	1	6
VII. ..	15	4	3	4	7
VIII. ..	4	1	2	2	1

1. It is evident on inspection of this table for Classes I. to III., that, as has been remarked on a previous page, the biological methods employed will not afford the means of deciding between a wholesome and an unwholesome natural water. Several of the waters believed to be fairly wholesome for human consumption, certainly in use for drinking purposes on a large scale, are marked "suspicious," while not one of the waters believed to have proved themselves pernicious when used by man are set down as "dangerous."

2. In many cases the waters which produced most decided effects upon the rabbits contained *very large* amounts of organic matter, so large as to probably invalidate a comparison with the natural waters or with much more dilute specimens of artificial preparation.

3. On the other hand, we find in several instances, on comparing the pathological results from three different strengths of a solution of the same organic material, that it is not the strongest which has produced the most marked effects.

4. In probable support of the idea that it is not mainly the quantity of organic matter, but the presence and

* Preliminary Report on the results of an investigation, made by direction of the National Board of Health, as to the chemical methods in use.

† "Methods for Judging of the Wholesomeness of Drinking-water." From "Journal of the Franklin Institute," February, 1881.

‡ *Comptes Rendus*: 84, 301; 85, 22, 1018. *Jour. Chem. Soc.* (Lond.), January, 1878, 44; July, 1879, 429. CHEMICAL NEWS, November 4, 1881, 217, &c.

* It is possible that salt may have been sprinkled over this hay in curing it, as is sometimes done, though I have no special reason to suppose so. It was upland, not salt-marsh, hay.

nature of low organisms which render drinking-water unwholesome, such cases deserve attention, as No. 83 in contrast with Nos. 84 and 85, and also Nos. 131, 132, and 133 (if the deaths of comparison rabbits be not considered to vitiate the results) in contrast with Nos. 134, 135, and 136. Here the pernicious character of waters containing relatively but very little organic matter seems to be distinctly indicated.

5. It is pretty plain that much difficulty in the interpretation of the biological results arises from two great differences of absolute strength in the solutions of organic matter used. In any future attempt to extend investigation in this direction it would be well to more nearly equalise the dilution, though it might perhaps prove necessary to use in all cases more organic matter than is usually found in potable water of natural origin.

Chemical Results as to Animal in Contrast with Vegetable Organic Matter in Water.

1. In general the conclusions are sustained which have been usually drawn in regard to the source of organic matter, based on the more highly nitrogenous character of that from animal than that from vegetable *debris*. This remark applies to the ratio of organic C : N obtained by the combustion process (although the value of the figures is much reduced by the errors in the method which have been pointed out), and also to the amounts of albumenoid ammonia obtained, and the consumption of oxygen from acid permanganate.

2. But the necessity for caution in drawing such conclusions, or the propriety of substituting for the statement that a given water is polluted by, say, animal matter, rather the simple assertion that the polluting material is of highly nitrogenous character, is illustrated by such cases as Nos. 89, 90, and 91, containing the alkaline washings from the manufacture of starch, and Nos. 98, 99, and 100, containing the refuse from canning tomatoes. These waters might well be supposed to be contaminated with animal matter from the evidence afforded by the chemical results, interpretated in the usual way.

3. On the other hand, the results for Nos. 104, 105, and 106, containing a water infusion of human fæces, especially the C : N ratio, might be taken to indicate the presence of vegetable matter. This fact, well deserving attention from a sanitary point of view, is opposed to the evidence of pollution obtained where urine alone is concerned, and might modify the conclusions drawn in cases involving drainage from mixed solid and fluid excreta. The fact itself is intelligible in view of the tendency to accumulation and ultimate rejection from the intestines of the vegetable fibre* of our food and the products of its limited alteration, as well as the highly carbonaceous character of the biliary discharges.

4. The different rate of removal from water of organic carbon and organic nitrogen is in one form illustrated by the comparison of No. 119 with No. 120 and No. 121, all three containing the watery liquid in which the body of a dead animal had been macerated, as also No. 128 in contrast with Nos. 129 and 130, all containing washings from wool. The true effect of the changes taking place in the water is, however, blended with and partially obscured by the effect of difference of strength on the errors which have been pointed out belonging to determinations by the combustion process. The bearing of such changes in the C : N ratio, from both causes, on the conclusions to be drawn as to the source of pollution, is very obvious.

5. Dr. Smart, in interpreting his results by the albumenoid-ammonia process, aided, however, in some cases, by his application of the Kubel form of the permanganate process, has for most of the waters in which the organic matter was of known character (though unknown at the time to *him*) attempted to distinguish between that of vegetable and that of animal origin, and his conclusions are given in column 45 of Table X. On examining these it will be seen that in a very large proportion of cases he has been right, while some of those in which his deductions are incorrect are intelligible in the light of full consideration of all the facts. Thus, he has referred Nos. 105 and 106, containing infusion of human fæces, to the class of vegetable matter, this case having been alluded to above; and Nos. 108 and 109, containing drainings from a pile of stable manure, to the same class, this being in many respects an analogous case, and, indeed, a more strongly marked one of its kind.

(To be continued.)

* The infusion was strained but not filtered. It contain a good deal of very fine suspended material.

NOTICES OF BOOKS.

Elementary Chemical Arithmetic, with 1100 *Problems.* By Sydney Lupton, M.A., Assistant Master in Harrow School. London: Macmillan and Co.

Some years ago Prof. R. Galloway threw out the suggestion that chemical facts might be more firmly and clearly fixed in the mind by the use of numerical problems on the properties and reactions of substances. Hence has arisen, ultimately, the present volume, which to the chemists of the earlier part of the century would have seemed a strange aberration. Its nature will perhaps be better understood by means of examples. We find the following questions:—50 grms. of potassium chlorate are heated: what mass of oxygen is given off? A grm. of bleaching-powder is boiled with water and cupric oxide: what volume of oxygen at 14° is given off? The *Great Eastern* is 679 feet long, 82 feet broad, and 62 feet deep: find each dimension in metrès. (We do not see anything of a chemical nature in this question). 100 grms. of gypsum are heated: what volume of steam at 300° is given off? A solution of hydrogen dioxide (density 1·455) gives twenty times its volume of oxygen when boiled: find its percentage composition by volume. Under the head "The Atmosphere" there occur some questions whose right to be viewed as chemical is at least questionable. Thus:—Westminster Hall is 290 feet long, 68 feet wide, and 110 feet high: how many tons of air does it contain?

The area of the basin of the Thames is 6000 square miles: a rainfall of 3·937 inches upon it is how many cubic metres of water? On October 14, 1881, the pressure of wind at Greenwich was 53 lbs. per square foot: how many grms. per square centimetre is the pressure equivalent to? The pressure on the same day at Birkenhead was 77 lbs. per square foot: how many tons pressure was there on a wall 50 feet high and 60 feet long? If the rate of wind was 65 miles per hour, how many feet per second was it?

A steel wire 1 m.m. square will just carry 70 kilos.: how many tons will a rod of such steel one foot square sustain?

A cubic crystal of rock-salt weighs 40·2 grms.: find the length of its edge.

How many yards of wire $\frac{1}{12}$ inch in diameter can be made from an ounce of magnesium?

Under "*Iron*" (p. 110, No. 9) we find the problem—"On January 18th, 1881, the barometer in London stood at 30·961 inches: how many m.m. high was it?

Again, under "Cobalt and Nickel," occurs the curious question—"If a cubic foot of water weighs 62·4 lbs.: find the diameter in inches of a cast-iron (density 7·25) 32 lbs. cannon ball?"

Finally, under chromium, we read (p. 221, No. 8)—"The three most elevated buildings in Europe are the Hospice de St. Gotthardt, 2075 m.; the Hospice de St. Bernard, 2491 m.; the Observatory on Mount Etna, 2942 m. above sea-level: find each of these altitudes in feet!"

Leaving out of view the many non-chemical questions,

of which we have not noticed a fourth part, we have now to turn to the general value of the book. To us it seems that as an adjunct to a full course of actual laboratory work it will prove exceedingly useful. But in schools and colleges like those of England, where there is already such a strong propensity to teach physical science by books, pen, and paper instead of by experiment and observation, there is a possibility that this treatise, or rather the system which it expounds, may be made to serve as a substitute for an actual practical training. This result, we think, would be very deplorable; for as far as we able to judge, a man might be able to answer every question in the book and yet be utterly imcompetent to execute an analysis, to conduct an investigation, or even to identify the simplest body placed before him. But we repeat, as an adjunct to experimental instruction it may be made to play an important and much needed part.

The Elements of Machine Design. By W. Cawthorne Unwin, B.Sc. Fourth edition, revised and enlarged. London: Longmans, Green, and Co.

This work, which forms one of the series of "Text-Books of Science" issued by the above publishers, is evidently appreciated, since a fourth edition has been found necessary within five years from its first appearance. This is the more satisfactory as affording proof that the frequent occurrence of mathematical symbols in its pages has not rendered it, as was foretold by certain authorities, a mere algebraical puzzle to practical men. There can be no occasion for us to summarise the teachings of a work evidently so well known, and which scarcely falls within the ordinary limits of our cognizance. We will therefore merely express our pleasure at the success of a book which instead of supplying mere receipts and formulæ lays down principles.

Handbook of Patent Law of all Countries. By W. P. Thompson, C.E. London: Stevens and Sons. New York: Van Nostrand.

It may be thought a bold undertaking to sum up the patent laws of all countries in a treatise of 90 pages. It must, however, be admitted that the author has treated his difficult subject with much ability, and that no little disappointment, loss, and litigation would be saved were the principles here laid down familiar to inventors. The author in his opening paragraph points out implicitly the distinction between a patent and a monopoly. "The inventor gives to the public what it did not possess before—the full details of a new invention; the crown in return gives the inventor the exclusive right of working that invention for a limited period, at the end of which time the full benefit of the discovery reverts to the public." There is only one word which can here be objected to, *i.e.*, "reverts," which naturally and etymologically means that something which has once been the property of a man becomes his again after having for a season passed out of his possession. Now the right or power which falls to the public when a patent lapses is something which they never possessed before.

It is remarkable how by the present state of the law one of the original objects of the patent-system is nullified. That original object was to promote the arts and manufactures in this country by encouraging inventions at home, and by facilitating their importation from abroad. But we now grant patents to aliens residing abroad, who have not the remotest intention of working such patents in the United Kingdom. In fact their motive is to prevent such working. By this principle England is placed at a great disadvantage as compared with other countries, which insist upon an invention being worked in their territories as one of the conditions on which a patent is granted. It has been suggested that the best means of putting a check to this growing practice would be to render the importation from abroad of any article, the manufacture of which is patented in England, contraband. It would then become the patentee's interest to work his invention in England or to grant licenses. However, it is the purpose of the author merely to explain the law as it is and not to point out its defects or to propose improvements. The work, so far as it aims at going, will be extremely serviceable. Great and due weight is laid on the necessity for a thorough search before taking any steps. But chemical inventions may chance to have been anticipated by publication without ever having been the subject of a patent. Hence as far as they are concerned it is prudent to search technological works and journals. It is to be regretted that some recent arrangements of the Commissioners have made searches more difficult.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 5, July 31, 1882.

Period of Variable Condition which precedes Detonation, and the Conditions under which the Explosive Wave is Established.—MM. Berthelot and Vieille.—According to the observation of the authors the propagation of the explosive wave is a phenomenon quite distinct from ordinary combustion; it takes place only when the ignited section exerts the greatest possible pressure upon the next section,—that is to say, when the ignited gaseous molecules possess the maximum speed, and consequently the maximum *vis viva* of translation, which is merely the mechanical translation of the fact that they preserve almost the totality of the heat developed by the chemical reaction.

Electric Resistance of Glass at Low Temperatures.—G. Foussereau.—For ordinary glass, of sp. gr. 2·539, expressing the resistances per c.c. in millions of megohms, the author obtained the following results:—

Temperatures.	Resistances.
+61·2	0·705
+20·0	91·000
−17·0	7970·000

To form an idea of the greatness of this last resistance we may remark that it represents about twice the resistance of a copper wire, of 1 square millimetre section, extending from the Earth to Sirius. Hard Bohemian glass, of sp. gr. 2·431, is from ten to fifteen times more conductive than ordinary glass at the same temperature. Crystal glass, of sp. gr. 2·933, is from 1000 to 1500 times more insulating than common glass at the same temperature.

Heat of Solution of some Mixtures.—P. Chroustchoff.—On taking four salts containing two acids and two bases we obtain two systems of salts of the same empirical composition, but with a different distribution of the acids and the bases. The solution-heat of these mixtures enables us in certain cases to infer the constitution of such mixtures. The author has not succeeded in finding for ammonium sulphate a fact indicated by Rüdorff for ammonium nitrate—that evaporation at 100° gives a system of four salts, whilst an evaporation in the cold gives merely a system of two salts, always the same, independently of the initial temperature.

Action of Ammonia upon Copper Oxide.—E. J. Maumené.—Copper oxide is considered by some chemists as soluble in ammonia. Others have observed that the presence of an ammoniacal salt is needful. The author concludes from his experiments that the compound cuprammonium does not exist. The so-called ammoniacal

salts are never formed of an acid combined with H_3NCuO, but always contain more than 1 equiv. ammonia to 1 of copper. Without hypothesis the sulphate is tribasic, the carbonate monobasic, and the phosphate sexbasic.

Composition of Wines prepared by Petiot's Process.—M. Aimé Girard.—The author finds that in wines prepared by this process the quantity of total extractive matter, of tartar, of tannin, and colouring-matter is smaller than in natural wines of the same growth.

Ethers of the Glycol, $C_{22}H_{14}O_2$.—G. Rousseau.—This memoir does not admit of useful abridgment.

Preparation of Acetyl-cyan-acetic Ether, and some of its Metallic Derivatives.—A. Haller and A. Held.—Acetyl-cyan-acetic ether has an acid reaction, and yields well-crystallised metallic derivatives.

Conditions of the Formation of the Rosanilines.—MM. A. Rosenstiehl and Gerber.—According to the authors we know at least six different rosanilines, isomeric or homologous. They confirm the conclusions of MM. E. and O. Fischer, according to which the concurrence of an alkaloid of the para-class is absolutely necessary for the production of magenta under normal industrial conditions.

Novel Use of Electrolysis in Dyeing and Printing.—Fr. Goppelsrœder.—(See page 89).

Formation and Decomposition of Acetanilide.—M. Menschutkin.—Not suitable for abstraction.

Products of the Distillation of Resin.—A. Renard.—The author finds that the carbide $C_{10}H_{18}$, described in a former memoir, has not a constant composition, but is a mixture of a carbide, C_9H_{18}, with a small quantity of a carbide of the aromatic series.

Journal de Pharmacie et de Chimie.
August, 1882.

Note on the Barks of Remigia.—G. Planchon.—A pharmacological paper.

On Combustion effected by means of Nitrogen Binoxide.—M. Berthelot.—Already noticed.

On Plastered and Deplastered Wines.—P. Carles.—The author considers the removal of sulphuric acid from wines by means of salts of barium as a remedy worse than the disease. There is the risk of an excess of barium chloride remaining in the wine, and the certainty that the barium sulphate and the tartrate (which is likewise formed) are not absolutely insoluble, especially the latter.

MISCELLANEOUS.

The late Mr. Grosjean.—We wish to correct an error in our obituary notice of this gentleman. He was chemist at the Citric and Tartaric Acid Works of Sir J. Lawes, and not at the Chemical Manure Works as we had been given to understand.

The Siemens Gold Medal and Prize.—An annual medal and prize of the joint value of 20 guineas have been founded by Dr. C. W. Siemens, F.R.S., "with the object of stimulating the students of King's College, London, to a high standard of proficiency in metallurgical science." The first award will be made at the end of June, 1883, and will depend in part on an essay on some given subject, partly on a written examination on the metallurgical lectures, and partly on work done in the laboratory. The subject appointed for the essay for 1883 is the "Manufacture of Steel, suitable for Ship and Boiler Plates." It must be illustrated with freehand sketches and mechanical drawings to scale, and must be sent in to Prof. Huntington not later than June 30th next. The competition is open to matriculated students who have studied in the Applied Science Department for at least two years, and who have subsequently made metallurgy a special study.

British Association for the Advancement of Science.—The following are the names of the Officers and Committee of Section B (Chemical Science) of the Southampton Meeting of the British Association:—

President—Prof. G. D. Liveing, M.A., F.R.S.

Vice-Presidents—A. G. Vernon Harcourt. M.A., F.R.S.; Prof. H. E. Roscoe, Ph.D., LL.D., F.R.S.; F. A. Abel, C.B., F.R.S.; W. Crookes, F.R.S.; Prof. J. Crafts; Prof. De Chaumont, F.R.S.; J. H. Gladstone, Ph.D., F.R.S.; Prof. A. W. Williamson, LL.D., F.R.S.; W. Weldon, F.R.S.

Secretaries—Harold B. Dixon, M.A.; Prof. P. P. Bedson, D.Sc. (Recorder).

Committee—A. Angell, Ph.D.; Prof. Attfield, Ph.D., F.R.S.; W. Lant Carpenter, B.A.; A. E. Fletcher; D. Howard; Prof. A. K. Huntington; F. Maxwell Lyte; T. H. Rowney; J. Millar Thomson; Prof. Tilden, D.Sc., F.R.S.; V. H. Veley, B.A.

The Papers brought before the Section were as follows:—

F. A. Abel, C.B., F.R.S.—On the Legal Flashing Test for Petroleum.

H. B. Dixon—The Influence of Aqueous Vapour on the Explosion of Carbonic Oxide and Oxygen.—A Lecture Experiment.

H. B. Dixon—The Velocity of Explosion of Carbonic Oxide and Oxygen with varying quantities of Aqueous Vapour.

Prof. J. Crafts—On the Boiling-points and Tension of Vapour of a number of Organic Substances determined with the Air-Thermometer.

Prof. Divers and Marachika Shimosé—On the Occurrence of Tellurium and Selenium in Japan.

Prof. A. K. Huntington—Report of the Committee on the Photographing of the Ultra-Violet Spark-Spectra emitted by Metallic Elements and their Combinations.

Dr. Marshall Watts—Report of the Committee for the Preparation of Tables of Wave-lengths.

Prof. von Baumhauer—On the Application of the Diamond to Mineralogical and Chemical Analysis.

J. M. Thomson—On the Action of Component Salts as Nuclei on Supersaturated Solutions of certain Compound Salts.

Prof. J. M. Crafts—On the Decomposition of Potassium Chlorate.

Prof. W. A. Tilden, D.Sc., F.R.S.—Hydrocarbons of the Formula $(C_5H_8)n$.

C. T. Kingzett—On the Activity of Oxygen and the Mode of Formation of Hydrogen Dioxide.

Prof. J. Sakurai—Metallic Compounds containing Bivalent Hydrocarbon Radicals. Part 3.

Prof. Rücker—Report of the Committee on the Methods employed in the Calibration of Mercurial Thermometers.

Prof. Schuster, Ph.D., F.R.S.— Report of the Committtee on Spectrum Analysis.

Prof. Liveing, M.A., F.R.S., and J. Dewar, M.A., F.R.S.—On the Reversal of the Spectral Lines of Metals.

C. W. Siemens, D.C.L., F.R.S., and Prof. A. K. Huntington.—On the Electric Furnace.

A. G. Vernon Harcourt, M.A., F.R.S.—The Aerorthometer, an instrument for correcting the Measurement of a Gas.

Charles T. Heycock, B.A.—A Revision of the Atomic Weight of Rubidium.

W. Marriott—On a Method of obtaining Ammonia from Shoddy and Allied Substances.

TO CORRESPONDENTS.

D. L.—Apply to the Secretary, Royal College of Chemistry, South Kensington.

"*Cyanures.*"—The "white paste" referred to in our review of Slater's "Manual of Colours and Dye Wares" is tin sulphocyanide.

T. B.—Radiometers have already been made with one side of the vanes coated with a phosphorescent powder. Persevere and try the xperiment for yourself.

THE CHEMICAL NEWS.

Vol. XLVI. No. 1189.

ON THE ORIGIN AND FORMATION OF THE DIAMOND IN NATURE.

By A. B. GRIFFITHS, F.C.S., &c.,
Medallist in Chemistry and Botany.

In this short note the author is desirous of pointing out that we can theoretically account for the formation of crystallised carbon in nature; although scientific men generally hold the opinion that the "origin of the diamond is entirely unknown." We know that the diamond has been found in a fine-grained sandstone in Brazil, and is principally found in an alluvial matrix of sandstone and quartz pebbles. Knowing these facts and that there are only three methods by which crystals are formed, namely, by fusion, by solution, and by sublimation; and as the diamond has been found in sedimentary rocks, and in an alluvial matrix of sandstone and pebbles; and knowing that sandstone and pebbles are produced by the action of water, hence their name of aqueous rocks; and as aqueous or sedimentary strata are often fossiliferous, we may draw an inference that the carbonaceous matter of the fossils (plant and animal remains) has been dissolved by highly heated water aided by great pressure existing in the crust of the earth.

It is a well-known fact that highly heated water aided by pressure can dissolve silica, as in the Geysers of Iceland, &c., where it is deposited round the mouth of the vent forming "the sinter" and also we have the experimental researches of De Senarmont (*Ann. de Chimie*, III., xxxii., 129), and others on the artificial production of crystallised minerals, as quartz, mispickel, corundum, heavy spar, &c., by the prolonged action of water at high temperatures and pressures; and I think we can see no reason why highly heated water or water gas should not have the power of dissolving the carbonaceous matter of fossiliferous plants and animals, and then on cooling depositing the carbon in the crystallised condition forming the gem known as the diamond. As to whether the diamond was formed by sublimation we can draw no inferences from facts or from nature; so must put this method of forming crystals on one side, as not being able to solve the problem; and further, the diamond cannot be formed by fusion, because we know that crystallised carbon in the form of graphite is formed by fusion (as "kish" in the manufacture of pig-iron).

Therefore, it appears from these views on the subject that the diamond has been formed in nature by the solvent action of highly heated water or water gas aided by enormous pressure on the carbonaceous matter of fossils contained in sedimentary rocks followed by slow cooling.

THE PROCESSES OF MM. A. CLASSEN AND A. VON REISS FOR THE DETERMINATIONS AND SEPARATIONS OF METALS BY THE ELECTROLYTIC METHOD.

Report by V. FRANCKEN.

Since the discovery of the process for the electrolytic determination of copper, various chemists have sought to utilise this simple and elegant method for the determination of other metals. Whilst in the attempts made hitherto the separation of copper succeeds best in a nitric solution, an ammoniacal solution is employed for the precipitation of nickel and cobalt, and a solution in potassium cyanide for zinc and cadmium. The exactitude of the results depends on strict observance of the conditions which we shall explain.

For instance, the precipitation of copper gives quantitative results only if the proportion of nitric acid in the solution is exactly that which has been established: the precipitation of cobalt and nickel is successful only if a determinate quantity of ammonia and ammonium sulphate has been employed. The electrolytic solution of the chlorides has not been hitherto directly practicable, so that it was first necessary to transform them into sulphates. Except the well-known separation of copper from the metals which are not precipitable in a nitric solution, and from those which are conveyed to the opposite electrode in the state of peroxides, the electric current has not yet been applied as a means of elimination in quantitative analyses. As will be seen below, copper, zinc, nickel, cobalt, iron, manganese, bismuth, tin, cadmium, whether existing as sulphates, chlorides, or nitrates, may be precipitated much more quickly and simply than they have been hitherto, and some of these metals may also be separated in one and the same solution.

Determination of Cobalt.

If we add to the solution of a salt of cobalt an excess of neutral potassium oxalate, and if the clear solution of oxalate is submitted to electrolysis, the intense red colour soon passes to a deep green, which becomes gradually feebler as the cobalt is deposited in the metallic state at the negative electrode. The potassium oxalate is converted into carbonate by the current, and by degrees there is deposited along with the metallic cobalt a precipitate of cobalt carbonate. This precipitate is dissolved by adding cautiously oxalic or dilute sulphuric acid, and the whole of the cobalt is separated by the continued action of the current until the liquid again becomes alkaline.

The electrolytic separation of the cobalt proceeds much more rapidly if the potassium oxalate is replaced by ammonium oxalate, which forms with the compounds of cobalt a double salt readily soluble, and if care is taken to add merely as much ammonium oxalate as is necessary to form the double salt of cobalt. There is deposited along with metallic cobalt a red insoluble cobalt oxalate, which is only slowly reduced by the current. To prevent this separation, the liquid, to which has been added ammonium oxalate in excess, is heated, and 3 to 4 grms. of solid ammonium oxalate are further dissolved. The boiling solution, when exposed to the influence of the current, deposits the cobalt in the form of a grey adhesive coating. By this process, with two Bunsen elements, about 0·2 grm. of cobalt may be separated in the course of an hour. When the reduction is complete (which may be ascertained most simply by adding ammonium hydrosulphate to a small sample of the liquid taken out with a capillary tube), the positive electrode is withdrawn from the liquid which is decanted off, and the precipitate is washed several times with water, then with alcohol, and finally with absolute ether. The residue of cobalt is then dried in an air-bath at 100°, and in a few minutes gives a constant result.

Determination of Nickel.

We proceed precisely as in the determination of cobalt *i e.*, we add to the solution ammonium oxalate in excess, heat, and add further about 4 grms. of the solid salt. The separation of nickel is effected as rapidly as that of cobalt: the nickel is deposited in a grey compact stratum, which, remains firmly attached to the electrode.

Determination of Iron.

The authors have used in these assays a solution of chloride and a solution of sulphate, and have proceeded exactly as above. The electrolysis goes on perfectly without separation of any compound of iron if there is present a sufficient quantity of ammonium oxalate. The

iron separates out in a brilliant mass of a steel grey colour firmly attached to the platinum. The reduced iron may be exposed for days to the air without any perceptible oxidation.

Determination of Zinc.

Zinc is separated from its solution as a double salt as easily and as rapidly as the preceding metals. The reduced zinc has a dark grey colour, and remains very firmly attached to the electrode. The separated metal cannot be dissolved by heating with dilute acids: in general it appears as a dark coating, which can be detached only by heating the capsule to redness, and treating the residue afresh with acid.

Determination of Manganese.

It is known that manganese can be separated as peroxide from a solution to which nitric acid has been added. But, according to the author's experiments, the precipitation is complete only when the quantities employed are small, when but little nitric acid is used, and when the rinsing takes place without interruption of the current. If the manganese is converted into a soluble double compound by the introduction of an excess of potassium oxalate, and if the solution is then electrolysed, all the manganese is precipitated at the positive electrode. If ammonium oxalate is employed the precipitation is not quantitative. The peroxide separated is not firmly attached to the electrode. Hence it is separated by filtration and transformed into Mn_3O_4 by heating.

Determination of Bismuth.

This assay presents some difficulty. We do not succeed in separating the metal as a compact mass adhering to platinum, and the bismuth is always obtained in the same state whether it is precipitated from an acid solution from the solution of a double salt of ammonium and of oxalic acid, or from a solution to which potassium tartrate has been added. If we give the platinum the greatest possible surface, and fill the capsule to the brim, we may, with a small quantity of bismuth, effect the rinsing in water, alcohol, and ether without loss. If in this operation particles of metal are detached from the capsule, they must be collected on a weighed filter and determined separately. In these assays we add to a nitric solution of bismuth a sufficient excess of ammonium oxalate. In the electrolytic decomposition we observe at the positive electrode a precipitation of peroxide, which slowly disappears. To preserve the reduced metal from oxidation it is necessary to remove the last traces of water by an abundant washing with alcohol and anhydrous ether.

Determination of Lead.

In a nitric solution lead behaves like manganese. When the quantity of peroxide separated is so considerable that it no longer remains firmly attached, and when it passes mechanically to the negative electrode, we cannot effect the determination without considerable loss resulting from the re-solution of the peroxide. The results are very uncertain.

If we submit the double oxalate to electrolysis all the lead present is indeed deposited in the state of metal, but it is so quickly oxidised on exposure to the air that it is rarely possible to dry it without change, even in a current of coal-gas. The electrolytic determination of this metal cannot therefore be recommended.

Determination of Copper.

Copper is separated very rapidly and easily from the double salt which it forms with ammonium and oxalic acid if only a sufficient quantity of ammonium oxalate is added. Weak currents cannot be used for the determination of considerable quantities of copper, as in this case the metal does not attach itself firmly enough to the electrode. The authors employ a strength of current corresponding to about a development of 330 c.c. of gas hourly, and can separate 0·15 grm. metallic copper in about twenty-five minutes.

Determination of Cadmium.

If the double oxalate of ammonium and cadmium is electrolysed, we obtain the cadmium in the form of a grey coating, which though not adhering very firmly to the electrode undergoes no loss if washed with caution.

Determination of Tin.

Tin can be very well determined electrolytically. It separates either from a hydrochloric solution or from the solution of a double ammonium oxalate in the state of a fine grey coating. If we use the potassium salt instead of ammonium oxalate, the electrolysis presents difficulties, for there appears at the opposite pole a basic salt which is not reduced. If the tin is separated from an acid solution the current must not be interrupted during rinsing—a precaution not necessary when employing the ammonium oxalate. When the tin is detached from the platinum capsule it presents phenomena similar to those described under zinc. As a general rule there remains a black residue on the electrode.

Determination of Antimony.

In a hydrochloric solution antimony is precipitated in the metallic state, but not firmly attached. If to the solution of trichloride we add potassium oxalate the antimony is easily reduced, but the metal is still not attached firmly to the electrode. A firmly adhesive coating may be obtained by the addition of an alkaline tartrate, but the separation takes place too slowly.

The precipitation of antimony succeeds very well in a solution of its sulpho-salts. We add hydrogen sulphide to the solution, which may contain free hydrochloric acid; we neutralise with ammonia, and add ammonium hydrosulphate in excess. The reduction is accelerated by the addition of a little ammonium sulphate. The antimony is separated at the electrode as a fine light grey precipitate, firmly attached if the precipitation has not been hastened by the use of too strong a current. When the reduction is complete the liquid is decanted off, and the residue cleaned in the ordinary manner.

Determination of Arsenic.

Arsenic cannot be separated quantitatively either from an aqueous or a hydrochloric solution, or from one to which ammonium oxalate has been added.

In the aqueous solution, as well as in the oxalic, a part of the arsenic is reduced to the state of metal, whilst in the hydrochloric solution it is all volatilised as arsenamine if the action of the current is sufficiently prolonged.

Separation of Iron and Manganese.

The separation of the two metals is only possible by preventing the formation of manganese peroxide until the greater part of the iron has been precipitated. We effect this object by the addition of sodium phosphate or more easily by the addition of a large excess of ammonium oxalate.

In both cases there appears, under the influence of the current, the characteristic colouration of permanganic acid, which disappears afterwards at the negative electrode. When the greatest part of the ammonium oxalate has been transformed by the current into ammonium carbonate, the colour becomes permanent in consequence of the formation of manganese peroxide. We add, in the outset, ammonium oxalate to the liquid, apply heat, dissolve further 3 or 4 grms. ammonium oxalate in the liquid, and electrolyse at once. The separation of the two metals takes place immediately and exactly, especially if the quantity of manganese is small. It appears as peroxide at the positive electrode, whilst the iron is deposited at the negative. If the proportion of the manganese is more than double the quantity of the iron, the precipitation of the latter will last longer. It is then

necessary, in order to effect a complete separation, to re-dissolve the deposit of peroxide in oxalic acid, adding the latter without interrupting the current, so long as the liquid has a red colour.

In separating the two metals the authors find it useful not to apply too strong a current (2 Bunsen elements are sufficient), and not to reinforce it unless compelled in consequence of too large a quantity of manganese, so as to re-dissolve the peroxide. When the assay is concluded it is not prudent to let the current act, as then a little peroxide is deposited very firmly upon the iron, and must be dissolved off in oxalic acid, after decanting off the liquid, or the electrolysis must be repeated. As we have already remarked in treating of the determination of manganese as peroxide, the precipitation of this metal from a solution of ammonium oxalate is not quantitative. We must therefore boil the liquid which holds in suspension the greater part of the manganese in the state of peroxide, so as to decompose the ammonium carbonate. The rest of the ammonia is then neutralised with nitric acid, and the manganese is transformed into sulphide by the addition of ammonium hydrosulphate. The manganese sulphide is strongly heated in a current of hydrogen and weighed directly.

Separation of Iron and Aluminium.

This separation, which offers serious difficulties by the ordinary methods, is easily effected by electrolysis. If we submit to electrolysis a solution (of ammoniacal oxide of iron and of aluminium ammoniaco-oxalate), to which a large excess of ammonium oxalate has been added, the iron is separated first as a coating firmly attached to the negative electrode, whilst the aluminium remains in solution as long as the quantity of ammonium oxalate is greater than that of the ammonium carbonate formed. If there is ultimately produced a precipitate of alumina the solution is then almost entirely free from iron. A few drops of the liquid holding the aluminium in solution are tested from time to time with ammonium hydrosulphate to find if iron remains and the current is interrupted as soon as no reaction is produced.

To make the determination we add ammonium oxalate in excess to a neutral or slightly acid solution. We may also, if needful, neutralise with ammonia. We add further ammonium oxalate in the proportion of 2 or 3 grms. per 0·1 grm. of oxide, and the hot solution is immediately electrolysed. The current must not be allowed to act until all the aluminium is precipitated along with the iron. A part of the aluminium would then adhere to the iron so that it could not be detached. Then, as it has been said with reference to the separation of manganese, the iron must be re-dissolved in oxalic acid, the liquid containing the aluminium having been previously decanted and the electrolysis repeated.

In order to precipitate completely the alumina from the liquid which has been freed from iron we add ammonia, heat for some time, and proceed in the ordinary manner. If the quantity of alumina is not greater than that of iron this method gives immediately accurate results. In the contrary case the precipitate of aluminium is dissolved and electrolysed again, adding oxalic acid cautiously and not interrupting the current.—*Revue Universelle des Mines.*

Elasticity of Rarefied Gases.—E. H. Amagat.—At the lowest pressures which have been experimentally reached (two-tenths of a millimetre) there does not appear to be produced any abrupt change in the law of the compressibility of gases; they still follow the law of Mariotte. It may certainly occur that a sufficient rarefaction, acting like a great elevation of temperature, may cause gases to follow the law $p(v-a)=c$, as in the case of hydrogen; but it is far from this to the limit of which M. Mendeleef and M. Siljerström, a state in which gases become infinitely little compressible.—*Comptes Rendus.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING JULY 31ST, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

August 3rd, 1882.

SIR,—We submit herewith the results of our analyses of the 181 samples of water collected by us during the month of July, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 181 samples, two were recorded as slightly turbid, and five as very slightly turbid. The remainder were found to be bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from July 1st to July 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, three were recorded as "very slightly turbid," and one as "slightly turbid." The remainder were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, one was recorded as "very slightly turbid," the remaining 25 samples being found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, one was recorded as "very slightly turbid," and one as "slightly turbid," the remaining 24 samples being well filtered, clear, and bright.

Of the 25 samples from the mains of the Grand Junction Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, the whole were found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

It will be observed that, despite the storms so frequent during the month, the general degree of freedom from turbidity of the water, though less complete than that which was noticeable throughout the two preceding months, was, on the whole, very satisfactory; while in respect of colour, aëration, and freedom from excess of organic matter, the previous excellent condition of the water was fully maintained.

We have the honour to remain, Sir,
Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.*

By Prof. J. W. MALLET, F.R.S., University of Virginia.

(Concluded from p. 102.)

Biological Results as to Animal in Contrast with Vegetable Organic Matter in Water.

1. Decidedly the most noteworthy result under this head is the well marked pathological effect produced upon rabbits by the injection of waters contaminated solely by such vegetable matter as would usually be esteemed harmless. An account has been given on previous pages of the general report of the repeated experiments, with water containing an infusion of dead forest leaves (No. 68), all leading to essentially the same result. A like effect followed from the experiments with the peaty waters of the Dismal Swamp (Nos. 78 and 79).

While there have hitherto been occasional allusions by sanitary writers† to slight indisposition now and then experienced by persons drinking the peat water of mountain streams, it has been usually assumed that peaty water is *not* unwholesome, strong language on this head being often used,‡ and that, in general, organic matter of vegetable origin is harmless, or comparatively harmless, while that of animal origin is highly dangerous.§ The results above referred to indicate that, under the special conditions of the experiments with rabbits, vegetable matter representing mainly or largely alteration products of woody fibre may be in a high degree pernicious.

2. It will be seen that for nearly all the waters classed as "dangerous" by Professor Martin and Dr. Hartwell the ratio of organic C : N was rather high.

3. The above conclusion as to the apparent possibility of vegetable organic matter proving itself decidedly injurious has to be qualified by observing that in the well marked cases of such results the amount of organic matter present in the water was large, and it would not be safe to affirm on this evidenee alone, that similar waters, if diluted to the ordinary potable standard,‖ would still prove themselves capable of causing disease or death in the animals experimented on; indeed, the evidence tends rather the other way, so far as the experiments go which were made by injecting the rabbits with *the same quantities* of weaker solutions. But, on the other hand, water containing as much vegetable organic matter as No. 78 is often used for drinking purposes in peaty districts, and this very Dismal Swamp water has often been taken by choice as the supply for ships leaving port, and has been spoken of as a source of supply for the city of Norfolk; so that the discussion of wholesomeness or unwholesomeness of such water is not without practical interest.

4. If the theory be accepted, which has so much in its favour, attributing the production of disease by organic matter in drinking-water not to any specifically poisonous *substance* or substances, but to the presence and action of living organisms, it seems quite conceivable that a water containing organic matter of any kind, including vegetable matter, may be harmless at one time, and harmful at another, when perhaps a different stage of fermentation or putrefactive change may have been entered upon, and special organisms may have made their appearance or entered upon a new phase of existence. Thus there might possibly be safety in drinking a peaty water, or water filtered through beds of dead forest leaves, when fresh, danger when after a certain amount of atmospheric exposure bacterial organisms had become developed, and safety again, perhaps, after the growth of such organisms had fallen off and more or less of the available organic matter had been consumed. I have been informed that old ship-captains who have often carried the water of the Dismal Swamp to sea entertain a belief that this water undergoes a "kind of fermentation," after which it becomes remarkably good and wholesome. In support of some such idea as to different stages passed through by a water (containing vegetable matter) as to the development of organisms and sanitary character, leading to the possibility, on its being stored, of wholesomeness at one time and unwholesomeness at another, the microscopical and biological reports of Nos. 62, and 69, 70, and 71, are worthy of notice.

Evidence Afforded by Chemical Results as to Putrescent or Non-Putrescent Character of Organic Matter in Water.

1. Tidy has claimed* as one of the merits of the permanganate process, that it enables the distinction to be drawn between "putrescent and easily oxidisable" and "non-putrescent or less easily oxidisable" organic matter, and has given the results of some experiments to show that the former are, for the most part at any rate, disposed of within the first hour; hence his rule as to determining separately the consumption of oxygen in that time and in three hours, and comparing the results, by means of which comparison he says "we obtain data of great value by which to judge the nature of the organic impurity." In column 28 of Table X., I have given the ratio of the consumption of oxygen from permanganate used as directed by Tidy in 1 hour to that in 3 hours, the latter quality assumed = 100. The results for those waters, the nature of the organic matter in which was known, are obviously affected variously by sundry conditions, such as the different strengths of solutions, the presence together of both easily and less easily oxidisable matter, &c., but on the whole do not afford much support to the opinion expressed by Tidy. He distinctly assumes animal matter to be, at any rate as a rule, more "putrescent and easily oxidisable" than vegetable matter, but on examining the percentages in column 28, taking the averages for the different classes of waters, we find—

	Per cent.
Organic matter of vegetable origin :	
For Class IV.	84·0
For Class V.	80·8
Organic matter of animal origin :	
For Class VI.	74·5
For Class VII.	77·6
For Class VIII.	79·0

Thus, although the differences are not very great, the proportionate consumption of oxygen within the first hour is rather greater for those waters containing vegetable than for those containing animal matter. Again, judging merely by appearance, smell, &c., I should say that the waters in the foulest and most actively putrescent condition were those containing the alkaline washings from a starch factory (Nos. 89, 90, 91), the washings from the bag-filters of a sugar refinery (Nos. 92, 93, 94), the refuse from canning tomatoes (Nos. 98, 99, 100), infusion of human fœcal matter (Nos. 104, 105, 106), infusion of the body of a dead animal (Nos. 119, 120, 121), mixed drainings from a slaughter-house (Nos. 125, 126, 127), and the dejecta from typhoid fever patients (Nos. 137, 138; the average consumption of oxygen for all of these in one hour is 80 per cent of that in three hours; almost exactly the same with the mean of all the above figures for the five classes examined (giving them equal value), viz., 79·2 per cent.

2. On the other hand, Dr. Smart has expressed the opinion, based upon his previous extensive experience with

* Preliminary Report on the results of an investigation, made by direction of the National Board of Health, as to the chemical methods in use.

† Angus Smith, in Chemical News, June 25, 1869; 304. Ekin, "Potable Water," p. 15; foot-note. 6th Report of Pollution of Rivers Commission, p. 34.

‡ Tidy, *Jour. Chem. Soc.* (Lond.), Jan., 1879; 65. Ekin, "Potable Water," p. 15.

§ Frankland, "Water Analysis," 93-97. Tidy, *Jour. Chem. Soc.* (Lond.), Jan., 1879, 80-83. Ekin, "Potable Water," pp. 12, 13, 14, 15, &c. K. Haines, "Methods for Judging of Wholesomeness of Drinking Waters," p. 11. De Chaumont, *Arch. Ch. Pharm.*, xvii., 124.

‖ See Sixth Report of Pollution of Rivers Commission, p. 54.

Jour. Chem. Soc. (Lond.) Jan., 1879; 78, 80, 97.

the albumenoid-ammonia process, aside from his work with it in connection with the present investigation, that *gradual* evolution of albumenoid-ammonia indicates the presence of organic matter, whether of vegetable or animal origin, in a fresh, or comparatively fresh, condition, while *rapid* evolution indicates that the organic matter is in a putrescent or decomposing condition. In column 45 of Table X. will be found his application of this principle of interpretation to his results obtained from the waters examined; the detailed facts as to the rate of evolution of albumenoid-ammonia in the measures of distillate successively collected will be found in Appendix D. It will be seen that in a very large proportion of the cases before him Dr. Smart has interpreted correctly the general character of the water as to putrescence or comparative freshness of condition of the organic matter. Examples, however, of erroneous results from this principle of interpretation are furnished by Nos. 77, 92, 93, 94, 125, 128, and 131, nearly all of which, it may be observed, were very dilute liquids, and perhaps by the waters (Nos. 113, 114, 116, 117, and 118) containing mixed sewage from Richmond and Washington, though these, also quite dilute, can hardly be quoted as examples involving a known degree of putrescence on the part of the organic matter.

Biological Results in connection with Putrescent or non-Putrescent Character of Organic Matter in Water.

On the whole the biological results obtained, taken in connection with the history and condition of the water samples in which the nature of the organic matter was known, are in accordance with the general belief that putrescent organic matter is more dangerous than that in a fresh or but slowly decomposing condition. Taking the twenty waters which have been noticed above, as containing the most obviously foul, evil smelling, and actively putrescent material, in some of vegetable, in others of animal origin, and comparing these with the lists of waters, as classified by Professor Martin and Dr. Hartwell, we find nine classed as "dangerous," and seven as "suspicious"; of the remaining four, the fact that two represented the weakest dilutions of materials, which in stronger solutions produced marked pathological effects, deserves to be noticed.

General Conclusions, with a view to Sanitary Applications as to the Value, Separately and Collectively, of the Different Processes of Water Analysis which have been under Examination.

1. It is not possible to decide absolutely upon the wholesomeness or unwholesomeness of a drinking-water by the mere use of any of the processes examined for the estimation of *organic matter*, or its constituents.

2. I would even go further, and say that, in judging the sanitary character of a water, not only must such processes be used in connection with the investigation of other evidence of a more general sort, as to the source and history of the water, but should even be deemed of secondary importance in weighing the reasons for accepting or rejecting a water not manifestly unfit for drinking on other grounds.*

3. There are no sound grounds on which to establish such general "standards of purity," as have been proposed, looking to exact amounts of organic carbon or nitrogen, "albumenoid ammonia," oxygen of permanganate consumed, &c., as permissible or not. Distinctions drawn by the application of such standards are arbitrary, and may be misleading.

4. Two entirely legitimate directions seem to be open for the useful examination by chemical means of the organic constituents of drinking water, namely, first, the detection of *very gross* pollution, such as the contamination of the water of a well by accidental bursting or crushing of soil-pipes, extensive leakage of drains,* &c., and secondly, the periodical examination of a water supply, as of a great city, in order that, the normal or usual character of the water having been previously ascertained, any suspicious changes which from time to time may occur shall be promptly detected and their cause investigated.

5. In connection with this latter application of water analysis, there seems to be no objection to the establishment of *local* "standards of purity" for drinking water, based on sufficiently thorough examination of the water supply in its usual condition.

6. With the facts of this investigation before me, I am inclined to attach special and very great importance to a careful determination of the nitrites and nitrates in water to be used for drinking.

7. If I had entrusted to me the charge of watching a large city water supply I should use all three of the principal processes for the examination of the organic matter present; each gives a certain amount of information which the others do not afford.

Under circumstances admitting only of the use of simpler means of investigation, the albumenoid ammonia and permanganate processes might be employed together, but in no case should one only of these methods be resorted to, such a course entailing practically the neglect of carbon on the one hand or nitrogen on the other.

Practical Suggestions Drawn from the Experience of the Investigation now Reported on as to the Use in their Present Form of the Chemical Processes Studied.

Examination of Water Samples in General.

1. Great care should be taken that water samples be placed in the hands of the analyst and their examination begun with the least possible delay after they have been collected. The changes which take place, sometimes rapidly, on keeping, may seriously affect the results, especially in the case of waters much polluted by foul organic matter.

2. It is very desirable that, besides examining a water in its perfectly fresh condition, samples of it should be set aside, in half-filled but close glass-stoppered bottles, for some time—say 10 or 12 days—and one of these examined every day or two, so as to trace the character and extent of the changes undergone. Not only may conclusions be drawn from such a series of observations as to the general stability or decomposability of the organic matter present, but light will be thrown upon the changes which may be expected to occur under ordinary conditions when the water is stored for use, as in cisterns, wells during periods of drought, or carelessly allowed to remain stagnant in pitchers, water-coolers, &c.

Combustion Process.

1. In applying this process, no matter how skilled or well trained the analyst may be, duplicate or even triplicate concordant results should be insisted upon before accepting the determinations as trustworthy.

2. In order to avoid the presence in the atmosphere, about the water-bath used for the evaporation, of ammonia derived from coal-gas, the bath should be heated by steam

* It will not do merely to throw all doubts on the side of the rejection of a water, as has been more or less advocated by writers on water analysis, for there are often interests of too serious character involved in such rejection to admit of its being decided on, save upon really convincing evidence of its necessity. In view of the great and increasing difficulty of securing an adequate supply of water of satisfactory character for very large cities, is it an unpractical fancy that there may yet come to be provided a double supply through separate pipes; 1st, of water for drinking and cooking purposes only; and 2nd, of water less carefully selected as to source and storage for bathing, washing, house and street cleaning, extinguishing fires, &c., the former at any rate dispensed through meters to regulate consumption?

* Dr. J. S. Billings, U.S.A., of the National Board of Health, has suggested to me in conversation a useful subject of inquiry, viz., the possibility of tracing up the passage of polluting material through a soil by bleaching samples of the soil itself, taken at various distances from the source of pollution, or from the water likely to be affected and chemically examining the liquids obtained.

brought in a small, closed pipe from a distant boiler, preferably situated in another room, and the waste steam and condensed water therefrom should be in like manner carried off to a safe distance.

Albumenoid-Ammonia Process.

1. In order to avoid the uncertain ending of the collection of ammonia, whether "free" or "albumenoid," it would be well to adopt the rule that the distillation be stopped when, and not before, the last measure of distillate collected contains less than a *certain proportion*—say one per cent—of the whole quantity of ammonia already collected. This would in many cases involve the necessity of replenishing the liquid contents of the retort with ammonia-free water.

2. In order to diminish the loss of amines or other volatile forms of nitrogenous matter, a separate distillation should be made with alkaline permanganate added *at once*, in addition to the usual course of treatment prescribed by Wanklyn—distillation begun with sodium carbonate, and continued after addition of the alkaline permanganate. The results of the two separate distillations should then be compared.

3. In reporting the results obtained by the albumenoid-ammonia process, including the determination of free ammonia, the details of the evolution of ammonia, as collected by separate measures of distillate, should always be given.

Permanganate Process.

1. In view of the evidence obtained rendering probable the loss of organic matter by volatilisation in the use of acidified permanganate at a boiling temperature, the Tidy form of the process is rather to be recommended than that of Kubel if but one be used.

2. On the other hand, the advantage of more extended oxidising action, and the greater *general* accordance of the results by the Kubel process with those for organic carbon by the combustion process, make it desirable that as far as possible the same advantages should be secured by substituting the influence of time for that of temperature, and that the time during which the permanganate is allowed to act in the Tidy process should be increased to at least 12, better to 24, hours, *several* determinations (on different samples set aside at the same time) being made at such intermediate intervals as 1, 3, 6, 9, and 12 hours, in order to trace the progress of the oxidation.

Suggestions as to Possible Improvements on the Processes Examined Deserving Further Investigation.

Combustion Process.

1. I would propose to evaporate the water, not under ordinary pressure and in contact with the atmosphere, as usual, but as the specimens of water were evaporated for the biological experiments, in a closed vessel immersed in a water-bath and connected with a good (water jet) air pump, so as to secure a nearly complete removal of air, with a condensing worm to dispose in part of the aqueous vapour given off. It would not do to simply place the water in a flask, since the residue could not be removed for combustion, but it would not be difficult to arrange a suitable vacuum vessel, with wide mouth and tightly clamped on cover, within which might be placed the usual glass dish to receive the water, and the feed might be managed through a nearly capillary tube with a glass stop-cock. By such an arrangement the evaporation might be effected within a moderate time at a fixed temperature much lower than the boiling point, thus probably reducing any loss from simple valatilisation of organic matter; the nearly complete exclusion of air would tend to greatly diminish or do away with loss of organic matter by oxidation, and permit of large reduction in the quantity of sulphurous acid used; for the same reason the tendency to formation of sulphuric acid would be reduced to a minimum, and the absorption of ammonia from the atmosphere about the dish would be altogether prevented. In testing this last-named effect, two bulb-tubes containing pure sulphuric acid might be interposed between the vacuum chamber and the pump; the contents of the one to be tested for ammonia given off from the water, those of the other to guard against any trace of ammonia coming back from the outside air during irregular action of the stream of water.

2. In order to avoid loss during the evaporation of readily volatile substances, such as butyric, valerianic, &c., acids, to dispense with the necessity for the uncertain and unsatisfactory correction for ammonia lost by dissociation, to get rid of the influence on the determination of organic nitrogen of any errors in the determination of the total ammonia, and to avoid corresponding difficulties arising from the presence of nitrates if these be allowed to remain, it might be well to evaporate at first with the addition of a small excess of magnesia (as recommended by Lechartier), thus removing all ammonia, and then, the water having been brought down to a small volume, add a moderate excess only of sulphurous acid* with a drop of a solution of a ferrous salt (as directed by Frankland), and complete the evaporation to dryness—the whole process to be carried out in a jet-pump vacuum, as above suggested.

3. Further experiments are desirable in order to completely determine the merits and defects of the Williams ("copper-zinc couple") method for the removal of nitrates.

4. Some preliminary experiments of my own seemed to show that nitrates and nitrites may be completely reduced by evaporating to a small bulk with no great excess of phosphorous or hypo-phosphorous acid, guarding against the evolution of phosphuretted hydrogen by the low temperature employed, then adding magnesia in small excess and completing the evaporation, thus leaving the residue in a pulverulent instead of sticky condition, easy of removal from the dish, and probably allowing of complete combustion without inconvenience from the final oxidation of the small excess of phosphite or hypophosphite, and without any wrapping up of carbon particles. This plan deserves to be carefully tested.

Albumenoid-Ammonia Process, Including Determination of Free Ammonia.

1. In order to prevent, or at least to largely reduce and render uniform, the loss of ammonia from imperfect condensation, I would prefer to effect the distillation, not by a lamp-flame, but in a retort of uniformly determined shape and size, uniformly immersed in a bath of saline solution or other suitable material kept at a uniform temperature—say 1 2° or 105° C.—by means of steam, and to condense in a glass worm, surrounded by ice-water, sufficiently long to bring the distillate to a uniform temperature, not exceeding, say, 5° C.

2. It would be perhaps still better to conduct the distillation in a completely closed apparatus, with a fixed difference of temperature between the retort and the far end of the fully effective condensing tube, with a glass stop-cock to draw off the distillate in successive measured portions, and a little safety-valve (mercury or other) near the cold end to prevent any dangerous difference of external and internal pressure.

3. In the determination of *free* ammonia, with a view to distinguishing as sharply as possible between ammonia really existing as such or in ammoniacal salts and that found by breaking up of organic matter, it might be well to try a closed distilling apparatus connected with a (water-jet) air-pump, so as to maintain a partial vacuum within, keeping the retort at a fixed temperature much below 100° C. and collecting the whole of the ammonia in a flask and one or more bulb tubes containing rather weak mineral acid, interposed between the condenser and the pump. This would, however, be attended with the disadvantage of not readily permitting the progress of the evolution of ammonia to be traced by its collection in separate succes-

* I doubt, however, the possibility of fully r ducing nitrates, by means of sulphurous acid, if they are present in large quantity.

sive measures of distillate; and it would become necessary to ascertain whether the application of the Nessler test would be in any way interfered with by the sodium salts formed from the acid used to collect the ammonia.

4. In order to overcome, if possible, the most serious difficulty in the way of a correct determination of free ammonia, namely, the ready breaking up of urea (and other amides), when present, on heating with sodium carbonate, it would be well to ascertain at how low a temperature and within what time, if at all, ammonia really existing in ammoniacal salts could be completely driven off from an *extremely dilute* solution by adding a small excess of magnesia and maintaining a (water-jet) air-pump vacuum above the liquid, forming a stratum of small depth, with bulb tubes of acid between the liquid and the pump to intercept the ammonia, and guard tubes to prevent any being received from the air; in other words, to ascertain whether Schlœsing's method for the determination of ammonia admits of being applied to such excessively minute amounts of it as the water analyst is concerned with.

5. In the conduct of the albumenoid-ammonia process proper, *i.e.*, the distillation with alkaline permanganate, I would propose that the original volume of liquid in the retort be maintained *constant*, by running in at the proper rate, through a nearly capillary tube with a glass stop-cock, ammonia-free distilled water. And, in cases in which the amount of organic matter is so large as to wholly, or in great part, reduce the usual charge of alkaline permanganate, I would determine by a preliminary experiment at about what rate the reagent is used up, and would then progressively supply its solution, instead of simply pure water, at such a rate as to keep the original strength as nearly as possible unaltered.

Permanganate Process.

1. The principle involved in the last paragraph applies also to this process. Instead of using a fixed amount of permanganate at first, and adding a second or third charge only when the former has been completely reduced, there ought to be a fixed excess at the end of the action, or rather there should be present a constant excess all through the process. Hence, when a preliminary experiment has shown that more than the usual charge of permanganate will be needed, and about the rate at which it will be consumed, for the final experiment additional permanganate solution should be gradually dripped in, from a nearly capillary tube, at such a rate as to maintain the original excess as nearly as possible constant.

2. It is desirable that the process be carried on at a pretty nearly fixed temperature.* If the Tidy method be followed, a temperature of say 20° C., could, with a little management, generally be secured, and the flasks kept approximately at this point during the time required for the action.

Suggestions as to Further Investigations in General Connection with the Subject-Matter of this Report.

1. It is much to be wished that more extended biological experiments should be made upon the effects of water variously polluted on the lower animals, and that in such experiments the action of water introduced into the stomach as well as hypodermically injected should be tested, and other animals (such as dogs) used as well as rabbits.

2. It would be well to have chemical examinations, on a strictly uniform plan, from time to time made of the water supply in a few of the largest cities at periods when, not mortuary statistics, but the general assent of well-informed members of the medical profession, ascertained through local sanitary authorities, indicates unusual prevalence of, or unusual exemption from, the classes of disease most probably capable of origination from the organic pollution of drinking-water.

3. I would *especially* suggest a combined chemical and biological enquiry as to the possible effects upon living animals of the ferment or ferments of nitrification in different stages of that process. In connection with this some minor questions connected with the development of nitrites and nitrates from decomposing organic matter are pointed to, by facts observed in the course of the investigation now reported on, as deserving further examination.

Conclusion.—Acknowledgment of Assistance Received.

It remains only for me to record my thanks to the following gentlemen for aid of various kinds, obligingly rendered, in connection with the work which forms the subject of this report:—

To Prof. H. Newell Martin, of the Johns Hopkins University, for his kind consent to take charge of the biological part of the investigation.

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To Mr. Chas. E. Heald, Lynchburg, Va.; The Montague Paper Company, Turner's Falls, Mass.; Mr. Wright

* For experiments on the varying extent of action of permanganate upon organic matter in water at different temperatures, see *Bericht. d. Deutsch. Chem. Gesellsch.*, 14, 1015.]

Duryea, New York; Mr. T. Havemeyer, New York; Mr. P. Casamajor, New York; Dr. H. H. Longstreet, Bordentown, N.J.; Mr. H. C. Merchant, Charlottesville, Va.; and Mr. J. C. Hewitt, New York, for specimens of factory refuse of various kinds.

To Dr. W. C. Dabney, Charlottesville, Va.; Dr. F. P. Porcher and Dr. Allard Memminger, Charleston, S.C.; and Dr. D. M. Burgess, Havana, Cuba, for specimens of morbid material; and to a large number of other gentlemen in various parts of the country, who offered samples of suspected waters for examination, the evidence against which, however, did not appear sufficient to make them available for the purpose of the investigation in hand.

NOTICES OF BOOKS.

Light, a Course of Experimental Optics Chiefly with the Lantern. By Lewis Wright. With illustrations. London: Macmillan and Co.

We have here a clearly written and abundantly illustrated manual, apparently designed for the guidance of science teachers. Algebraical formulæ have been avoided, the author seeking to explain the phenomena and the laws of light in a purely experimental manner. In this respect the work occupies an exceptional position among optical treatises, and it will in consequence prove valuable to a certain class of minds who are essentially non-mathematical, but who need not on that account find themselves excluded from a knowledge of the methods and the results of physical science.

The author, in his preface, quotes certain remarks made lately by Prof. Huxley in his capacity as an Examiner in the Science and Art Department. He reiterated, we are told, "a complaint well known at South Kensington as to the great difference between two kinds of what persons called knowledge. That which they had constantly to contend against in the teaching of science in this country was that many teachers had no conception of that distinction; for they thought it quite sufficient to be able to repeat a number of scientific propositions, and to get their pupils to repeat them as accurately as they themselves did." Now, if this difficulty has to be encountered "in this country," more than in any other,—which we neither affirm nor deny—is not the reason that our system of education is more examinational than that of other countries? "South Kensington" should ask itself whether it is not to blame for the complaint which it knows so well.

Mr. Wright seeks in the book before us to teach facts clearly and vividly as the base upon which generalisations have to be founded. As a means of class demonstration, the author in the majority of cases recommends the lantern. He treats successively of this instrument and its accessories, of rays, images, and reflection; of refraction, total reflection, prisms, and lenses; of dispersion, and the spectrum; the nature of light, its velocity, and the undulatory theory; of colour, where he upholds the Helmholtz-Maxwell doctrine of red, green, and violet as the three primary colours; of spectrum analysis; of phosphorescence, fluorescence, and calorescence, in which chapter he duly notes as exploded the notion once entertained of three superposed but independent spectra; of interference, of double refraction and polarisation, of polarising apparatus, of rotatory, circular, and elliptical polarisation, of optical phenomena of crystals in plane and in circularly polarised light; of polarisation and the colour of the sky, and of polarisation by small particles. There are 190 illustrations and diagrams, besides eight plates, and a full and accurate index.

We think that whoever fairly examines this book will agree with us that its teachings are on a level with the most recent position of optical science, and that they are expressed with rare clearness and simplicity.

The work, as we note with pleasure, is not examinational. It is not fitted up with a string of questions which have been or which may be asked at South Kensington, or elsewhere. The student who takes this work as his guide may perhaps fail to "pass," but he will be certain to "know."

The Student's Guide in Quantitative Analysis, intended as an Aid to the Study of Fresenius's System. By H. Carrington Bolton, Ph.D. New York: John Wiley and Sons. London: Trübner and Co.

This little work gives abridged methods for the quantitative analysis of a number of bodies, organic and inorganic, some of them of a very simple nature, such as barium chloride and magnesium sulphate, and others highly complex, such as iron-slag, titaniferous iron-ore, and urine. In the selection of the substances for whose analysis procedures are here laid down, the author seems to have been guided in part by their commercial importance, but in part also by their serving to exercise the student in analytical methods. In no case do we find directions for the determination of any of the rarer elements. The instructions given are brief,—indeed, the author himself speaks of their "fragmentary character,"—but this feature may be accounted for by his peculiar object. The book is intended, not as a substitute for Fresenius, but as a key or guide to the right use of his classical work. There are, also, under almost every heading, references to other works, where the analysis of the substance in question, or the determination of some one of its constituents, is treated of in full. Thus, under Dolomite we have references to Fresenius, to the *Comptes Rendus*, and the *American Chemist*. Under "Silver Coin" Dr. Bolton speaks of a piece of apparatus under a name which will somewhat mystify any English student into whose hands the book may fall. He directs a filtrate to be heated to boiling in a "casserole." From the context he evidently means a "capsule." As "an aid to the study of Fresenius's system," which is what the author intends and professes it to be, this little work will be found useful.

CORRESPONDENCE.

CHEMISTRY AND COURTESY IN GERMANY.

To the Editor of the Chemical News.

Sir,—Perhaps it may interest your readers to know of the kindness and courtesy with which even such English chemical adventurers as myself are treated by men of the greatest reputation, in Germany, who seem for the most part to speak English very fairly. Prof. Kekulé, of Bonn University (to whom I had sent the proof of the article in the Chemical News, vol. xlvi., p. 33), caused me to be shown over the splendid chemical laboratory there, and suites of rooms belonging to it—the largest in Europe I believe—and then conversed with me about the subject of my paper. He seemed very much struck with the fact which I repeated to him, that an undoubted sodium orange flame (as that produced from *cryolite* before the blowpipe) *removes* the turbidity caused by the orange flame from platinum in a boric acid bead; as also by the argument I used that, according to Euclid, "the same cause producing exactly opposite results is a *reductio ad absurdum*." He told me that the Bonn course of chemistry is chiefly inorganic, and that the blowpipe is only taught there to beginners.

At Heidelberg, Professor Bunsen (to whom I had also sent a copy of my article) received me with the greatest kindness in his private library, in which I observed a full-length bronze statue of Berzelius. He led me to the sofa

and sat there with me—a mark of regard in Germany, I am told—and when I showed him my air-reservoir blowpipe and apparatus in a cigar-case, he said, "This is very beautiful,"—I suppose he meant "ingenious"—but he also said, "They did not teach the blowpipe at all there" (!) as it seemed to me, in a tone of regret. He told me "he would come oftener to England but for the horrors of the North Sea."—I am, &c.,

W. A. Ross.

28, Alexander Strasse, Stuttgart,
August 28th, 1882.

SUGAR ANALYSIS.

To the Editor of the Chemical News.

Sir,—I have noticed a communication from C. A. Crampton in your issue of July 14, 1882, and likewise R. H. Harland's reply two weeks later. The latter gentleman has, I think, given a sufficient answer to the criticism of Mr. Crampton, but I desire to supplement this answer by a few words.

Mr. Crampton states "that mixed starch and sugar do not polarise higher than pure cane sugars, but rather lower." Now as a matter of fact, as Mr. Harland has remarked, the starch sugars of commerce ordinarily used for mixing up to the present time, though some are of snowy whiteness, are *not highly converted*, and according to my experience do not contain on the average above 75 per cent pure dextrose, polarising generally above 100 if the solution is not allowed to stand too long before observation; this polarisation, however quickly, lowers on standing or heating, and may reach 75 after two or three hours. Quite recently there has appeared upon the market here, though not manufactured extensively I believe, a well-crystallised dextrose made from corn starch, which, I take it, is probably 98 per cent pure dextrose; this article can be produced for about one-half the price of white sugar, and will, I fear, be largely used to adulterate the latter, for which purpose its physical properties well adapt it.

However, it is not at all necessary for a cane sugar to be mixed with a high-polarising starch sugar to make the complete analysis add up over 100—which is the test I have proposed in my manual for detecting the presence of starch sugar. A simple numerical calculation will show this plainly. Suppose, to make the case as unfavourable as possible from my point of view, 100 parts of a cane sugar containing 90 parts sugar, 3 parts glucose, and 7 of impurities, were mixed with 5 parts of high grade starch sugar containing 98 per cent dextrose, 2 per cent impurities, and polarising 75. Omitting the figures the mixture would polarise .. .. 89·20

and contain—

Dextrose	7·52
Impurities	6·76
	103·48

Thus we see that when the mixture actually polarises *less* than the cane-sugar adulterated, the analysis still adds up over 100, and the reason is not far to seek in the fact, that while the polarisation is only slightly lowered by the grape sugar the amount of dextrose and impurities added is proportionally large so as to bring up the result as we have seen. From my experience in the analysis of these adulterated sugars, I have found the three qualitative tests given in my manual as entirely reliable, and of great value when used according to the limitations which I have plainly pointed out for them; I am not afraid but what chemists of the requisite experience will endorse my position upon the matter.

By a confusion of thought my critic appears to consider that if the mixture polarises less than the sugar adulterated that he has proven his case. It seems hardly possible that he ever could have made a complete analysis of a sample of mixed sugar, and I submit that it has been clearly proved that he has been writing about a matter he does not understand.

In regard to Mr. Crampton's discourtesy, I think I can afford to let that pass, especially as Mr. Harland has already disciplined him for what is probably only a "youthful indiscretion."—I am, &c.,

J. H. Tucker, Ph.D.

New York, August 18, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 6, August 7, 1882.

Researches on the Action of Ethylenic Chlorhydrine upon the Pyridic Bases, and on Quinoleine.—M. Ad. Wurtz.—In this paper the author examines the action of ethylenic chlorhydrine upon aldehydine and α-collidine.

Influence of the Quantity of Gas dissolved in a Liquid upon its Surface-Tension.—S. Wroblewski.—Under pressures of from 1 to 30 atmospheres there exists a remarkable relation between the laws of solubility of carbonic acid in water and the surface-tension of the liquid. This relation may be expressed in the following manner:—1. The product of the surface-tension, α, by the pressure, P, to which the surface-tension is exposed, is proportional to the coefficient of saturation, S, which corresponds to that pressure,—that is to say, $\alpha P = AS$, A being a coefficient which depends on the temperature and increases with it. According to the first law of solubility, the temperature remaining constant, $\frac{S}{P}$ decreases in proportion as the pressure increases. Experiment shows that the decrease of α is proportional to the decrease of $\frac{S}{P}$. 2. The pressure remaining constant, and equal to n atmospheres (when n is greater than 1), it results from the laws of solubility that the quotient—

$$\left(\frac{S}{P}\right)P=n$$

$$\left(\frac{S}{P}\right)P=1$$

diminishes with the decrease of the temperature. Experiment shows that in this case the ratio of the tensions corresponding to these pressures—

$$\frac{\alpha P=n}{\alpha P=1}$$

diminishes also.

Numerical Relations between Thermic Data.—D. Tommasi.—The author announces the following law:—When a metal is substituted for another in a saline solution the number of calories liberated is for each metal always the same, whatever may be the nature of the acid which forms part of the salt, or of the halogen combined with the metal.

Researches on the Telephone.—A. d'Arsonval.—This memoir requires the accompanying illustration.

Equivalent of the Phosphorus Iodides.—L. Troost.—The equivalents of the phosphorus iodides, corresponding to 4 vols., are PI_3 and P_2I_4.

The Formation Heats of the Principal Palladious Compounds.—M. Joannis.—The author finds that hydrocyanic acid not merely decomposes palladious chloride

and bromide (dissolved in the corresponding potassium salts), but even the precipitated palladious iodide. This is a new verification of thermic theories. *A fortiori*, potassium cyanide ought to precipitate the palladious salts, by reason of its feeble heat of neutralisation.

Pyridic Bases derived from Brucine.—M. Oechsner de Coninck.—On distilling brucine and cinchonine with caustic potash there are formed simultaneously two series of isomeric pyridic bases.

Researches on Quinoleine and Lucidine.—M. Amé Pictet.—The author has studied the action of mono-chlorhydrine, epi-chlorhydrine, mono-chloracetic ether, dichlorhydrine, tribromhydrine, and allyl iodide upon quinoleine, and that of mono-chloracetic acid upon β-lutidine.

Journal de Pharmacie et de Chimie.
August, 1882.

Experimental Study on the Action of Potassium Permanganate upon Venoms, Virus, and Zymotic Diseases.—M. Vulpian.—A reply to M. de Quatrefages and M. de Lacerda. The author shows that potassium permanganate, when injected into the circulatory system, is a formidable poison, if introduced in doses sufficient to have any effect upon a poison which is already diffused in the blood. The bite of *Bothrops jacarandi* does not by any means prove invariably fatal in Brazil.

Preparation of Hypophosphoric Acid.—M. Isidore Corne.—The author half fills a large flask with a solution of copper nitrate, adds phosphorus, and heats in the water-bath. More phosphorus is then added, until the liquid is entirely decolourised. The product of the reaction—a mixture of phosphoric, phosphorous, and hypophosphoric acids—is filtered, and half saturated with sodium carbonate. Impure sodium hypophosphite crystallises out, and is purified by repeated crystallisation.

Justus Liebig's Annalen der Chemie,
Band 213, Heft 2.

Contributions to the Knowledge of Acet-acetic Ester.—Dr. C. Duisberg.—The author concludes that Lippmann's dibrom-aceton-carbonic ethyl and Conrad's dibrom-acet-acetester dibromide are non-existent; that in acet-acetic ester five atoms of hydrogen may be readily and successively replaced by bromine, forming five different substitution-products. The substitution of the remaining atoms of hydrogen is difficult, and probably is only practicable at higher temperatures. The view of Frankland and Duppa on the constitution of acet-acetic ester is criticised, and various considerations are urged against it.

On Ultramarine.—G. Guckelberger.—In this extensive memoir it is decided that ultramarine blue is a true, definite chemical compound. For its formation a temperature is required equal to the melting-point of zinc, which towards the end of the process should be somewhat raised. The author refers to the analogies existing between the compounds of silicon and those of carbon, and quotes the opinions of Woehler, Rammelsberger, &c., to this effect.

Bulletin de la Société Chimique de Paris.
June 20, 1882.

On Combustions effected by means of Nitrogen Binoxide.—M. Berthelot.

Observations on the Decomposition of Metallic Formiates in presence of Water.—M. Berthelot.—Two thermo-chemical papers, already noticed.

Russian Chemical Society.—Session of September 10/22, 1881.—The papers read include:—On the product of the reduction of succinyl chloride, and on normal γ-oxybutyric acid, by M. Saytzeff; on diallyl-ethyl-carbinol, by M. Smirensky. Action of sulphur upon alizarine at high temperatures; on the oxidation of anthraquinon in the cold; formation of sulphuretted hydrogen by the action of oleo-naphtha upon sulphur; and on a case of the transformation of tartaric into racemic acid: these four papers are all by M. Lidoff.

M. Lubavine communicated a memoir on the action of ammonium cyanide upon the aldehyds.

M. Menschoutkine gave an account of the influence of the molecular weight of homologous bodies in the so-called incomplete reactions.

M. Mendelejeff communicated some of the results which he has obtained on studying the petroleum of Baku, of sp. gr. 0·881 to 0·886. Among the products extracted from the tar of the petroleum of Baku, vaseline is found in large proportion.

M. Kajander presented to the Society the continuation of his researches on the speed of chemical reactions.

M. Wilm has studied the action of lighting-gas upon palladium, rhodium, and platinum. He concludes that an addition of palladium or of rhodium to platinum must make the latter metal less useful for chemical apparatus.

July 5, 1882.

Researches on Perchloric Acid.—M. Berthelot.

Detonation of Acetylene, Cyanogen, and Endothermic Compounds in General.—M. Berthelot.—Two thermo-chemical papers, already noticed.

On a Case of Isomerism of Dichlorated Camphor.—P. Cazeneuve.—The author describes a compound which differs from the normal dichlorated camphor in its fundamental physical properties.

On a New Monochloric Camphor.—P. Cazeneuve.—Already noticed.

Cosmos Les Mondes.
No. 14, August 5, 1882.

This issue contains no chemical matter which has not been already noticed elsewhere.

MISCELLANEOUS.

Electric Lighting by Incandescence.—After discussing the four systems of incandescent lamps—the Edison, Swan, Lane Fox, and Maxim—the Jury of the recent International Exhibition of Electricity at Paris write as follows in their official report:—"But none of them would have succeeded had it not been for these extreme vacua which Mr. Crookes has taught us to manage. The members of the Jury of Recompenses are anxious here to express to Mr. Crookes their high approval of his beautiful researches, and at the same time their regret that it is not in their power to award him a prize."

The Chemical Laboratory of Wiesbaden.—In the Summer Term, 1882, there were 60 students on the books. Of these, 44 were from Germany, 5 from North America, 3 from England, 2 from Austro-Hungary and from Russia, and 1 from Switzerland, Belgium, Spain, and South America. Besides the Director, Geh. Hofrath Prof. Dr. R. Fresenius, there are engaged as teachers in the establishment, Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, and Architect J. Brahm. The assistants in the instruction laboratory were two in number, in the private laboratory twelve, and in the Versuchsstation two. Besides scientific researches, numerous analyses were undertaken in the laboratory and the Versuchsstation on behalf of manufacture, trade, mining, and agriculture.

THE CHEMICAL NEWS.

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CHEMICAL LITERATURE.

An Address Delivered before the American Association for the Advancement of Science, at Montreal, August 23, 1882.

By Prof. H. CARRINGTON BOLTON, Ph.D., Vice-President.

The literature of chemistry, extending as it does through a period of more than fourteen centuries, varies greatly in character, in province, and in design; it partakes of the peculiar phases exhibited by the science at different epochs and depicts the experiences and thoughts of those who cultivated it in all ages. It may be studied from several points of view: the biographer searches the voluminous records to acquire knowledge of the intellectual activity of individuals; the historian unfolds the progress made by the science in a special field or in its entirety, with philosophical inquiries respecting effects and causes; the bibliographer, scarcely penetrating beyond the title-pages of the dusty tomes, laboriously catalogues them to facilitate the researches of others.

We do not propose to give you a biographical, an historical, or a bibliographical treatise, but rather to review chemical writings as sources of information and as portions of the world's literary productions. We shall concern ourselves less with the questions what were the personal history and life-work of a given author, and more with the queries what are the characteristics of the various classes of works at different epochs, what discoveries do they chronicle, and what was their influence on the contemporaneous science.

The very earliest information concerning chemical arts comes to us from that ancient nation supposed by some to have given its own name to the science itself: not only do the sculptured tombs and temples of Egypt pourtray with unimpeachable authenticity and wonderful accuracy the technical skill of that venerable people, but these same monuments are even now relinquishing their hold on long-buried treasures in the form of papyri, whose perplexing script no longer conceals their meaning from the erudition of Egyptologists.

Of these miraculously preserved papyri the most valuable to chemistry is that discovered by Prof. George Ebers at Thebes in 1872, and named after its learned discoverer. We have described this elsewhere* and shall not here enter into details. It is the most ancient medical work extant, being assigned to the sixteenth century B.C., and contains a vast amount of information on the medical practice and the pharmaceutical preparations at that remote period. The unknown author wrote less obscurely than many of a much later date, and when the whole papyrus shall have been deciphered it will prove an invaluable contribution to chemical history.

The most ancient manuscript treating exclusively of chemical operations is a Greek papyrus of Egyptian origin preserved in the Library of the University of Leyden. Its authorship is unknown, its date is placed by Reuvens in the third or fourth century A.D. This MS. consists of a collection of prescriptions and receipts for conducting various operations in metallic chemistry, such as the testing of gold and silver; the purification of lead, of tin, and of silver; the hardening of tin and of silver; the albification of copper, &c. It deals little with alchemy, though some of the receipts evidently refer to transmutations, as those entitled: "the preparation (artificial?) of silver;" "the preparation of gold;" "the purification of tin by silver," &c.

Reference is made to sandarach (realgar), cadmia (zinc ore), chrysocolla, cinnabar, natron (soda), mercury, and other chemical substances, but no receipts are given for their preparation. The author quotes from the Materia Medica of Dioscorides, who probably preceded him by about two centuries. It is to be regretted that the full text of this ancient manuscript has never been published; the little known of it foreshadows information of great interest.*

The great libraries of Paris, Rome, Venice, Milan, Escurial, Cracow, Gotha, Munich, and Cologne preserve a large number of Greek alchemical manuscripts of unknown authorship and uncertain date. Hoefer, the French historian of chemistry, refers them to the third and fourth centuries,† but other authorities with greater probability place them not earlier than the tenth and eleventh.‡

The most celebrated of these essays are attributed to Zosimus, of whose history nothing is certainly known, and bear these titles: "On Furnaces and Chemical Instruments," "On the Virtue and Composition of Waters," "On the Holy Water," "On the Sacred Art of Making Gold and Silver." In a treatise attributed to Synesius, we find a description of a hydroscopium or hydrometer which was re-discovered as long after as the sixteenth century.

In a treatise attributed to Olympiodorus, he cites as authorities Democritus, Anaximander, Zosimus, Pelagius, and Marie, a certain Jewess whom the later alchemists confounded with Miriam, Moses's sister.

In these manuscripts chemistry is called the "sacred Art," and the exceedingly obscure and figurative language in which they are written makes it well nigh impossible to separate fact from fancy; Hoefer has indeed attempted to discover modern chemical conceptions in the allusions to Egyptian myths and the chaotic collections of spagyric arcana.

Of systematic nomenclature there is absolutely no trace; indeed, each author seems to have aimed to write treatises intelligible only to himself, and we greatly doubt his success in even this respect. "Cadmia," we are informed, "is magnesia," and "magnesia is the female antimony of Macedonia;" "nitre is white sulphur which produces brass;" equally clear is the statement that the "apospermatism of the dragon is the mercury of cinnabar." That lexicons were early in demand is not surprising; in fact some of the most ancient MSS. are "vocabularies of the sacred art," but even with their assistance it is difficult to form satisfactory concepts of contemporary chemical science.

Suidas,§ a Greek lexicographer of the eleventh century, states that Diocletian having conquered the rebellious Egyptians (296 A.D.) destroyed their books on the preparation of silver and gold, lest becoming rich by the practice of that art they might again resist the Romans. Regrets at the wanton acts of this imperial biblioclast are tempered by the reflection that modern scholars are spared the study of such literary absurdities.

The Chinese, that curious people who always claim a hearing when the origin or antiquity of arts and sciences is under consideration, were acquainted at a very remote period with many branches of chemical technology. We do not know of any special chemical literature produced by them, but the researches of Rev. Joseph Edkins‖ and of Dr. W. A. P. Martin¶ make it highly probable that

(Works marked (*a*) are in the private library of the author).

* (*a*) "Quarterly Journal of Science," London, vol. 49, p. 95, Jan., 1876. See also: (*a*) "Materia Medica, Therapeutics and Pharmacy of the Ancient Egyptians," by Dr. Charles Rice, "Medical Record," vol. xi., p. 247, April, 1876.

* (*a*) *Lettres à M. Le Normne sur les papyrus bilingues et grecs . . de l'universite de Leide*, par. C. J. C. Reuvens. Leide, 1830. *Troisieme lettre*, p. 65. See also: (*a*) Kopp's *Beiträge zur Geschichte der Chemie*, I., p. 97, 1869.

† (*a*) Ferdinand Hoefer, *Histoire de la Chimie*, Paris, 1866, vol. I., p. 261.

‡ (*a*) G. F. Rodwell, "The Birth of Chemistry," p. 72, London, 1874.

§ (*a*) Hermann Kopp, *Geschichte der Chemie*, II., 150.

‖ "Miscellany or Companion to the Shanghai Almanac for 1857."

¶ (*a*) "The Chinese, their Education, Philosophy and Letters," New York, 1881.

scholars will yet discover contributions of no small importance to the early history of chemistry. Prof. George Gladstone* has endeavoured to show that the Chinese originated the doctrines and pursuits of alchemy and communicated it to the Arabians by whom it was disseminated throughout Europe.

The high state of civilisation and extraordinary intellectual development of the Arabians has left a deep impression on chemical science. Cultivated chiefly by physicians, attention was directed to its pharmaceutical applications, and in spite of the prohibitions of the Koran to the fascinations of alchemy. Of their extant writings, preserved in European libraries, only a portion have been edited; those best known partake of the poetical imagery and hyperbole characteristic of the Oriental mind. This is shown to some extent in the singular titles prefixed to their treatises, *e.g.*, "The Rise of the Moon under the Auspices of Golden Particles," by the alchemist Dschildegi; "A Poem in the Praise of God, of Mahomet, and of Alchemy; by Dul-nun-el-Misri.†

The well-known treatises of Geber,‡ "Of the Investigation of Perfection," "Of the Sum of Perfection," "Of the Invention of Verity," and "Of Furnaces," notwithstanding a bewildering style of composition, which seems to confirm Dr. Johnson's derivation of gibberish, from Geber, display very great familiarity with a large number of chemical substances and operations.

Geber's works are generally assigned to the eighth century, and consist chiefly of compilations from the "Books of the Ancients;" he mentions no author by name. They contain chapters devoted to the seven known metals, to the methods of distillation, calcination, cupellation, and other operations, to the preparation of saline substances, and to chemical philosophy. Geber adopted Aristotle's views of the constitution of matter from four principles, the hot and cold, the wet and the dry, and adds thereto: "Mercury and sulphur are the components of metals," a doctrine which with slight modifications prevailed for more than eight centuries. Geber describes the preparation of nitric acid, of aqua regia, and of mercuric oxide; he mentions the increase in weight of metals when calcined with sulphur, and gives the results of a rude quantitative analysis of crude sulphur. He constantly maintains the doctrine of transmutation of metals and gives a refutation of the ingenious arguments opposed thereto. His remarks on the qualifications of a chemist are most intelligent and are not inopportune in modern times; he urges the necessity of diligence, patience, learning, a temperate disposition, slowness to anger, and a full purse, "for this science agrees not well with a man poor and indigent," together with faith in the God who "withholds or gives to whom He will" the secrets of nature, and who will infallibly punish the foolish meddler with magical mysteries.

To detail fully our obligations to Arabian chemists is no part of our plan. They have left an indelible impression on the very language of the science, in the words alcohol, alembic, alkali, borax, and many others. All honour to the intelligent authors who a thousand years ago defined chemistry as the "Science of Combustion, the Science of Weight, the Science of the Balance!"§

In the middle ages intellectual activity was confined largely to the clergy, who controlled the schools of learning, the libraries, and nearly all sources of knowledge. University chairs were occupied exclusively by clerical professors,‖ literature and science were cast in ecclesiastical moulds. Scientific treatises were the production of monks and emanated from cloisters. Many distinguished philosophers mastered widely separated branches of learning: among these were Alain de Lille (b. 1114), celebrated as a physician, theologian, poet, and historian, who filled the episcopal chair at Auxerre; Roger Bacon (b. 1214), an English cordelier; Raymond Lully (b. 1235), a Franciscan friar; and Albertus Magnus (b. 1193), Bishop of Ratisbon. The latter, amid the monotonous routine of a Dominican monastery, found leisure to distinguish himself in astronomy, medicine, alchemy, and, according to his enemies, in necromancy. At this remote period, accusations of dealing with magic were not unfrequently made against those whose learning and skill in experimental sciences excited envy and superstitious zeal.*

To treat the writings of these eminent ecclesiastics as a part of chemical literature requires perhaps a stretch of the imagination, yet three hundred years ago they were regarded as masterpieces of the science and formed the text-books of students of alchemy. The writings of these ecclesiastical philosophers are as comprehensive as the branches of learning they cultivated, and incredibly voluminous; Albertus Magnus's collected works fill twenty-one folio volumes.† But a small fraction of these treatises are occupied with science and chemistry; and of this fraction there is in many cases a reasonable doubt as to their authenticity. In fact, nothing was more common than the ascription of work by an obscure second-rate writer to some celebrated philosopher of preceding ages, in order to give the work the stamp of authority,—a deception which, previous to the invention of printing, was more readily accomplished.

It became difficult, therefore, to distinguish the apocryphal writings from the genuine. The former, it is true, frequently betray themselves by anachronisms and other blunders, but many ingenious writers avoided such traps by adopting an enigmatical style worthy of the Delphian oracles.

Basil Valentine was the reputed author of works held in the very highest esteem by the alchemists of the Middle Ages, yet the very existence of this individual is seriously questioned. Mystery surrounds Valentine's entire history, and his writings were given to the world in a most dramatic manner; according to tradition they were hidden in the wall of a church at Erfurt, and long after his death a thunderbolt shattered the wall and revealed the precious documents.

Whether Valentine was a real personage or not the works ascribed to him exhibit great familiarity with many chemical substances and operations, though the obscure and incoherent style renders their intelligent perusal very difficult.

Valentine's celebrated "Chariot of Antimony,"‡ extolling the medical virtues of this metal, is perhaps the least obscure of his works; the "Twelve Keys of Philosophy,"§ with its singular plates, one of the most unintelligible; yet beneath the extravagant jargon characteristic of the period, glimpses are obtained of light and intelligence. The latter work presents clearly the theory that all metals are compounded of three principles: fixedness, metallicity, and volatility, represented respectively by salt, mercury, and sulphur, an hypothesis which long completely controlled chemistry until it gave place to the seductive theory of Phlogiston. It is uncertain whether the works ascribed to Valentine were first written in Latin or in German; his works were collected in the seventeenth century and have been through many editions.‖ Several

* (*a*) "The Birth of Alchemy," in the "Argonaut," Jan., 1876.

† Cf. (*a*) Ferdinand Wustenfeld, *Geschichte der Arabischen Aerzte*, Gottingen, 1840.

‡ (*a*) "The Works of Geber, the most famous Arabian Prince and Philosopher, faithfully Englished by R[ichard] R[ussell]." London, 1678.

§ (*a*) J. W. Draper, "History of the Intellectual Development of Europe," New York, 1862, p. 303.

‖ For more than a century after the founding of the University of Heidelberg, the chairs were exclusively filled by the clergy; the first nomination of a layman to a professorship in the Medical faculty in 1482, encountered violent opposition. Cf. Herman Kopp, (*a*) *L'état des sciences au moyen age, in Revue des Cours scientifiques*, vol. 7, '02, May 28, 1870.

* Cf. (*a*) Naudé, *Apologie pour tous les grands hommes qui ont esté accusez de Magie*, Paris, 1669. [The first edition was in 1653].

† Albertus Magnus, "Opera Omnia," Lugduni, 1651, 21 vols., fol. [Consulted in Harvard College Library, Cambridge].

‡ (*a*) Basil Valentine, "His Triumphal Chariot of Antimony, with Annotations of Theodore Kirkringius." London, 1678. See also (‖).

§ *Chymische Schriften*, p. 23.

‖ The sixth edition bears the title, (*a*) *Fr. Basilii Valentini Chymische Schriften, in drei Theile*, Leipzig, 1760.

of his treatises have been translated into English and into French.*

In the fifteenth century the newly-invented printing press was employed in the production of few works which can be regarded as chemical, and these were chiefly confined to isolated treatises of the ancient philosophers; in the sixteenth century the alchemists began to publish the results of their industry and speculations, and in the succeeding century a prodigious number of alchemical works were issued in Germany, France, and England, creating literature of an extraordinary type.

Some of these treatises, which are numbered by thousands, record valuable experiments made by enthusiasts seeking the philosopher's stone, but the majority contain "a crude mass of incoherent propositions and wild assertions, a mixture of poesy and insanity, in which all logical ideas are lost amidst the stilty phraseology, but through which breathed a blind yet fervent faith."† Great obscurity of style;‡ an enigmatical method of naming chemical substances which found its highest development in the use of arbitrary symbols and the pictorial representations of alchemical processes;§ the intimate association with astrology; the honest or affected intermingling of pious comments and prayers;‖ the extravagant claims to antiquity as respects authorship and processes;¶ the attempts to interpret the mythology of Egypt and Greece on an alchemical basis; the endeavour to associate the mysteries of Hermes with the sacred truths of the Christian religion,**—all combine to produce literary montrosities as fascinating to the student of chemical history as they are profitless to the practical worker in modern science.

(To be continued.)

* Cf. (*a*) *Bibliotheque des Philosophes Chimiques*, Paris, 1741, vol. 3.

† (*a*) Paul Lacroix, "Science and Literature in the Middle Ages," New York, 1878, p. 187.

‡ Cf. "Basil Valentine's Chariot of Antimony," p. 49.

§ Cf. (*a*) *Pretiosa Margarita Novella*, Veneti, 1546. [*Apud Aldi filios*].

‖ Cf. Geber, *op. cit.*, p. 23. "Glauber's Works," vol. 1, p. 277. "Basil Valentine's Works" (*passim*) and the following: "Take seven ounces of this prepared Venus [copper] and put it into a melting pot, . . . when you have finished this work give God thanks and remember the poor;" Raymond Lully, Philos. Exp. Chap. II., *ad finem*; in (*a*) Turner's edition, London, 1657.

¶ Cf. Olaus Borrichius. *De ortu et progressu chemiæ*, in (*a*) Mangetus's *Bibl. Chem. Curiosa*, vol. 1, p. 1.

** Cf. Sir George Ripley, Jacob Behmen, and especially Dionisius Andreas Freher's "Analogy in [Barrett's] (*a*) Lives of Alchemystical Philosophers," London, 1815, p. 121.

ASSAYS OF CINCHONA.††

In these assays it must never be forgotten that the point of greatest importance as well as of greatest difficulty is the complete exhaustion of the bark, and knowing when the exhaustion is complete. Next, it must be always borne in mind that different samples of bark differ very much indeed in structure and, therefore, in accessibility to the exhausting menstruum. Some are soft and spongy, and easily exhausted with a small quantity of liquid in a short time. Others, which do not sensibly differ in appearance of either the bark or its powder, are hard and compact, requiring more liquid and longer digestions. Hence, while the process formerly given is very nicely applicable to some barks, and is entirely sufficient for those upon which its details were adjusted, it does not do equally well for other barks, but may be so modified as to apply equally well to all.

This great difference in the facility with which different cinchona barks are exhausted has been too much overlooked, and it may be the principal cause of the disagreement between Drs. Biel and De Vrij, who, working by the same process, find a different length of time necessary for the digestion,—the former advising a digestion of four hours, while the latter finds one hour sufficient.

The principles upon which our former process is based are all confirmed by further experience. These are that amylic alcohol freely dissolves all the alkaloids of cinchona barks, but does not dissolve the salts of those alkaloids, and that it dissolves much less of the colouring-matter than other solvents; and the outline of the method is to break up the natural salts of the alkaloids in the bark, and fix the colouring-matters by lime in excess. Then to extract the free alkaloids with amylic alcohol, ether being added to facilitate the percolation and filtration. Then to convert the alkaloids into salts, and thus get them out of the amylic alcohol into a watery solution. Then to precipitate them from the watery solution in the presence of chloroform, which dissolves them freely, and finally to evaporate off the chloroform and weigh the residue as anhydrous alkaloids.

Take of the powdered cinchona 5 grms. = 77·16 grs.
Lime, well burnt, 1·25 ,, = 19·29 ,,
Amylic alcohol,
Stronger ether,
Purified chloroform,
Normal solution of oxalic acid,
Normal solution of sodium, and
Water, of each a sufficient quantity,

or, double all the quantities throughout, as well as size of vessels, &c., if the barks be poor, or if it be desired to divide the errors of manipulation.

Add to the lime contained in a 10 c.m. = 4 inch capsule, 30 c.c. = 1 fluid ounce of hot water, and when the lime is slaked, stir the mixture, add the powdered cinchona, stir very thoroughly and digest in a warm place for a few hours, or over night. Then dry the mixture at a low temperature on a water-bath, rub it to powder in the capsule and transfer it to a flask of 100 c.c. = 3·3 fluid ounces capacity, and add to it 25 c.c. = $\frac{5}{6}$ fluid ounce of amylic alcohol. Cork the flask and digest in a water-bath at a boiling temperature and with frequent vigorous shaking for four hours. Then cool and add 60 c.c. = 2 fluid ounces of stronger ether, sp. gr. 0·728, and again shake vigorously and frequently during an hour or more. Filter off the liquid through a double filter of 10 c.m. = 4 inches diameter into a flask of 150 c.c. = 5 fluid ounces capacity, and transfer the residue to the filter. Rinse out the flask on to the filter with a mixture of 10 volumes of amylic alcohol and 40 of stronger ether, and then percolate the residue on the filter with 15 c.c. = $\frac{1}{2}$ fluid ounce of the same mixture added drop by drop from a pipette to the edges of the filter and surface of the residue. Return the residue to the flask from whence it came, add 30 c.c. = 1 fluid ounce of the amylic alcohol and ether mixture, shake vigorously for five minutes or more, and return the whole to the filter. Again percolate the residue with 15 c.c. of the menstruum applied drop by drop from a pipette as before. Then put the filter and residue aside that it may be afterward tested in regard to the degree of exhaustion.

Boil off the ether from the filtrate in the flask by means of a water-bath, taking great care to avoid igniting the ether vapour, and also to avoid explosive boiling by having a long wire in the flask. When boiled down as far as practicable in the flask transfer the remainder to a tared capsule of 10 c.m. = 4 inches diameter, and continue the evaporation on a water-bath until the contents are reduced to about 6 grms. = 92 grs. Transfer this to a flask of 100 c.c. = 3·3 fluid ounces capacity, rinsing the capsule into the flask with not more than 4 c.c. = 64 minims of amylic alcohol. Then add 6 c.c. = 96 minims of water and 4 c.c. = 64 minims of normal solution of oxalic acid, and shake vigorously and frequently during half an hour. Pour the mixture while intimately mixed on to a well-wetted double filter of 12 c.m. = 4¾ inches diameter, and filter off the watery solution from the amylic alcohol into

†† From an "Ephemeris of Materia Medica, Pharmacy, Therapeutics, and Collateral Information," by Edward R. Squibb, M.D., Edward H. Squibb, S.B., M.D., and Charles F. Squibb, A.B. Brooklyn, N.Y., July, 1882.

a tared capsule of 10 c.m. = 4 inches diameter. Wash the filter and contents with 5 c.c. = 80 minims of water applied drop by drop from a pipette to the edges of the filter and surface of the amylic alcohol. Then pour the amylic alcohol back into the flask over the edge of the filter and funnel, rinsing the last portion in with a few drops of water. Add 10 c.c. = 160 minims of water and 1 c.c. = 16 minims of normal solution of oxalic acid; again shake vigorously for a minute or two, and return the whole to the wetted filter and filter off the watery portion into the capsule with the first portion. Return the amylic alcohol again to the flask, and repeat the washing with the same quantities of water and normal oxalic acid solution. When this has drained through, wash the filter and contents with 5 c.c. = 80 minims of water applied drop by drop from a pipette. Evaporate the total filtrate in the capsule on a water-bath at a low temperature until it is reduced to about 15 grms. = 241 grs., and transfer this to a flask of 100 c.c. = 3·3 fluid ounces capacity, rinsing the capsule into the flask with 5 c.c. = 80 minims of water. Add 20 c.c. = 0·66 fluid ounce of purified chloroform, and then 6·1 c.c. = 98 minims of normal solution of sodium, and shake vigorously for five minutes or more. While still intimately mixed by the shaking, pour the mixture upon a filter of 12 c.m. = $4\frac{3}{4}$ inches diameter well wetted with water. When the watery solution has passed through, leaving the chloroform on the filter, wash the filter and chloroform with 5 c.c. = 80 minims of water applied drop by drop. Then transfer the chloroform solution by making a pin-hole in the point of the filter, to another filter of 10 c.m. = 4 inches diameter, well wetted with chloroform, and placed over a tared flask of 100 c.c. = 3·3 fluid ounces capacity. Wash the watery filter through into the chloroform-wet filter with 5 c.c. = 80 minims of purified chloroform, and when this has passed through into the flask, wash the chloroform-wet filter also with 5 c.c. = 80 minims of chloroform, applied drop by drop to the edges of the filter. When the whole chloroform solution of alkaloids is collected in the flask, boil off the chloroform to dryness in a water-bath, when the alkaloids will be left in warty groups of radiating crystals adhering over the bottom and sides of the flask. Place the flask on its side in a drying stove, and dry at 100° C. = 212° F. to a constant weight. The weight of the contents multiplied by 20 gives the percentage of the total alkaloids of the cinchona in an anhydrous condition, to within 0·1 or 0·2 of a per cent if the process has been well managed.

The object of stirring the powdered bark into the slaked lime and water while hot is to swell and permeate the particles as rapidly as possible, introducing the lime solution into the innermost parts of the particles, and this process goes on during the digestion and drying of the mixture. Beside setting the alkaloids free from their natural combinations in the bark, the excess of lime so combines with and fixes the colouring-matters, that even with the red cinchonas the subsequent steps of the process are not confused or obstructed by colouring-matter.

Various other precipitants were tried with this and other menstrua, but none answered so well as lime. The menstruum of ether and alcohol with ammonia, recommended by Biel and adopted by Prollius and De Vrij, were tried, but did not do so well, as lime had to be subsequently used, while the creeping during evaporation was more difficult to avoid.

The digestion and shaking with amylic alcohol doubtless dissolves all the alkaloids present, and dissolves very little beside, but a portion of the solution remains absorbed by the spongy structure of the particles. Such portions can be percolated out on a filter with amylic alcohol and without ether, but the filtration is very tedious and troublesome, requiring more than a day. But by diluting the amylic alcohol with about three times its volume of stronger ether it is rendered very manageable, and the filtration and washings are accomplished in about an hour, leaving the residue practically exhausted. If this solution be evaporated either spontaneously or by a water-bath it creeps over the edges of the capsule badly, and no good result can be reached. But if it be boiled down in a flask in a water-bath as directed, there is no difficulty, for after the ether is driven off the remainder has no tendency to creep over.

In this part of the process great care must be taken that the ether vapour does not take fire. When evaporated to 6 grms. as ascertained by trying on a scale from time to time, the ether is all gone and a solution of the alkaloids in amylic alcohol remains. One prominent object of the next step of the process, namely, the washing out of the alkaloids from the amylic alcohol as oxalates, is to free them from waxy and fatty matters always extracted from the bark by all solvents which effect a complete exhaustion. In washing out the alkaloids these waxy and fatty matters are left in solution in the amylic alcohol, and with it are thrown away.

If this amylic alcohol be evaporated on a water-bath to a constant weight, the residue will amount to about a half of one per cent of the cinchona taken, and therefore if only a very rough estimate of the total alkaloids be needed, this may be obtained by continuing the evaporation of the amylic alcohol solution to a constant weight and subtracting a half of one per cent from the result.

As the alkaloids are all soluble in amylic alcohol, while their salts are not, a definite quantity of solution of oxalic acid being added, the alkaloids are washed out of the amylic alcohol as acid oxalates. But they are rather difficult to wash out completely, and hence three washings are directed. If close results are not needed, two washings are sufficient. In pouring the amylic alcohol back from the filter into the flask, over the edge of the filter and funnel, a little dexterity is required, and the rim of the funnel must always be somewhat above the filter, in order to be quite successful. The double filter well wetted with water, and kept well wetted, retains the amylic alcohol very well, while the watery solution drains off to the last drop. But should there be any minute holes in the paper, or should the paper not be kept well wetted, a very little of the amylic alcohol may get through; but if so, it does not matter, for it will go off with the vapour in the subsequent evaporation, or adhere to the capsule in an insoluble condition. The solution of the oxalates is too dilute for precipitation, and as it is not acid enough to injure the alkaloids by heat, it is evaporated to 15 grms. As this solution has no tendency to creep, the evaporation is best done on a water-bath. In the next step the alkaloids are precipitated in the presence of chloroform, and it makes a very notable difference in the result if commercial or impure chloroform be used, hence purified chloroform is directed. Having used in all 6 c.c. of normal solution of oxalic acid in converting the alkaloids into acid oxalates, it is only necessary now to add 6·1 c.c. of normal solution of sodium in order to be sure that the precipitation is complete to an alkaline reaction, yet without a sufficient excess of sodium to hold the alkaloids from the chloroform and hence the use of these normal solutions is important as well as very convenient. After a thorough shaking, the now free alkaloids are all dissolved in the chloroform, and it is only necessary to separate this completely in order to get them all. Here, again, a wet filter becomes a most complete and convenient mode of separation. The watery solution of oxalate of sodium goes through to the last drop, but not a particle of chloroform passes if the paper be good, and here a double filter is not needed; neither is it necessary to wash the filter very much. In the chloroform separation of the alkaloids a film of impurities, soluble in neither liquid, is apt to be present between the two liquids. This is often hardly a weighable quantity, and when small may be neglected and the chloroform solution be at once transferred to the tared flask for evaporation. But in close estimates it is easily separated in the way prescribed, by filtration of the chloroform solution through a chloroform-wetted filter into the flask. This chloroform-wetted filter not only ex-

cludes these impurities, but also any water that may drain out of the water-wetted filter. A pin-hole made in the point of the water-wetted filter is a very good way of transferring from one filter to the other.

The boiling down of the chloroform solution and drying the alkaloids to a constant weight and weighing them in a flask rather than in a capsule, is directed in order to have them in a condition convenient for estimating the ether-soluble alkaloids and quinia.

The above process gives a fairly good and trustworthy account of the total alkaloids in all the cinchona barks to which it has yet been applied, and is more conveniently and easily managed than any hitherto met with which is adapted to the moderate degree of skill possessed by this writer and by well-trained pharmacists generally. There may be, and doubtless are, other processes better adapted to the expert skill of the highly-trained chemist.

Estimation of Quinia.

After much labour, extended over many years, and the trial of all the principal processes which have been published, the writer is obliged to acknowledge that he has found no process for the accurate separation of the cinchona alkaloids which was within the scope of his ability to apply with success. The more complicated and delicate processes of the higher chemists seem only successful in their hands, or at least none of them have thus far come into any general use, and under these circumstances it seems only practicable, in a general way, to reach near approximations by some method which is simple and easy of application.

This much only is claimed for the following process:—

It is common to have the cinchona alkaloids divided into ether-soluble alkaloids, and those not soluble in ether. But this is a very inaccurate sub-division, for all are quite soluble in ether, whether the ether be absolute or 94 per cent, and the application of ether to any mixture will easily dissolve the whole. Thus either the powdered bark itself, or after having been mixed with milk of lime and dried, can easily be exhausted of alkaloids by ether alone. All that can be said is that quinia, quinidia, and cinchonidia are more soluble in ether than the other alkaloids, and that quinia is most soluble of all, and is very soluble,—so soluble that it dissolves in large quantity in ether that has been already saturated with other less soluble alkaloids. And further, that in the presence of any ordinary proportion of any or all the other cinchona alkaloids all the quinia of a mixture will be dissolved by ether if enough of this solvent be present to fully dissolve the quinia if that alkaloid was alone. It is, however, still useful to distinguish the more valuable cinchona alkaloids, namely, quinia, quinidia, and cinchonidia, as the ether-soluble alkaloids, because they can be roughly but still usefully separated by ether in such a way as to better define the values of various barks as they come into the markets for use, and the following process has been contrived to give a fairly good account of the so-called ether-soluble alkaloids as a group, if all are present, and a somewhat less definite account of the quinia as well.

Into the flask containing the total alkaloids, after these have been weighed, put first 5 grms. = 78 grs. of glass, which has been ground up in a mortar to a mixture of coarse and fine powder, and then 5 c.c. = 80 minims of stronger ether. Cork the flask and shake it vigorously until by means of the glass all the alkaloids have been detached from the flask and ground up in the presence of the ether into fine particles. In this way the definite quantity of ether, which is large enough to dissolve all the quinia that could possibly be present, becomes entirely saturated with alkaloids in the proportion of their solubility, and the solution will necessarily embrace all the very soluble ones as the quinia.

Next, mark two test-tubes at the capacity of 10 c.c. = 160 minims each, and place a funnel and filter of 7 c.m. = 2·8 inches diameter over one of them. Wet the filter well with ether, and then pour on to it the mixture of alkaloids, ether, and glass, from the flask. Rinse the flask out two or three times on to the filter with fresh ether, and then wash the filter, and percolate the glass with fresh ether, applied drop by drop from a pipette, until the liquid in the test-tube reaches the 10 c.c. = 160 minims mark. Then change the funnel to the other test-tube, and continue the washing and percolation with ether until the mark on the second test-tube is reached by the filtrate. Pour the contents of the two test-tubes into two small tared capsules, evaporate to a constant weight, and weigh them. The first capsule will contain what may be called the ether-soluble alkaloids. Subtract from the weight of these the weight of the residue in the second capsule, and the remainder will be the approximate weight of the quinia extracted from the 5 grms. of bark. These weights multiplied by 20 will give the percentage of ether-soluble alkaloids and of quinia.

The explanation upon which these conclusions are based is as follows:—

The quantity of ether used is abundant to dissolve all the quinia and most of the quinidia and cinchonidia, and presumably does so, and dissolves beside all that it is capable of holding of the less soluble alkaloids. This saturated solution is filtered off, displaced, and washed out. Then an equal volume of the solvent ether is applied to the residue containing the less soluble alkaloids, and is presumably nearly saturated by these, but contains no quinia and but little quinidia perhaps, though it contains as much of all the other alkaloids as did the first portion. If the two equal volumes of solvent, then, contain nearly equal quantities of the less soluble alkaloids, while the first contains nearly all of the more soluble ones, then it only needs that the weight of the second residue be subtracted from the weight of the first to leave only the weight of the more soluble alkaloids, such as quinia and quinidia, if the latter should be present.

In two good critical assays, one of red and the other of yellow cinchona, made for the purposes of this paper at this time, the red cinchona (succirubra of Ceylon) gave 0·335 grm. of total alkaloids, which is (0·335 × 20 =) 6·7 per cent. These total alkaloids then gave 0·210 grm. of ether-soluble alkaloids, which is equal to (0·210 × 20 =) 4·2 per cent, and this corrected by subtracting the 0·015 grm. of less soluble alkaloids or (0·015 × 20 =) 0·3 per cent, gives (4·2 − 0·3 =) 3·9 per cent of quinia. Then, as the ordinary sulphate of quinia contains about 73·5 per cent of quinia, this 3·9 per cent of quinia would be equal to (as 73·5 : 100 : : 3·9 :) 5·3 per cent of sulphate.

The yellow bark assayed at the same time (*Cinchona officinalis* from the Ootacamund) gave of total alkaloids 7·3 per cent. Ether-soluble alkaloids 3·48 per cent. Quinia 2·76 per cent. Equal to sulphate of quinia 3·75 per cent.

In connection with these two assays it is worthy of remark that here, as is very rarely the case in the experience of this writer, the red cinchona yields the smaller percentage of total alkaloids with the larger percentage of quinia. Usually the proportions are just the reverse of this between the red and yellow barks.

A Modification of Pettenkofer's Reaction for Bile Acids.—Pettenkofer's test for the bile acids is generally applied by putting in a test-tube a little of the liquid under examination, adding concentrated sulphuric acid and a fragment of sugar, and heating cautiously to 70° C. If a bile acid is present a splendid red colouration appears. This test is open to the difficulty that it is easy to add too much sugar, which becomes carbonised and turns the liquid brown, thus masking the reaction. To avoid this difficulty Drechsel recommends the use of syrupy phosphoric acid instead of sulphuric acid. The carbonisation of the sugar is thus avoided, but, as Becker found on repeating the experiment, no red colouration appears.—*Chemiker Zeitung.*

CALCIC HYPOCHLORITE.

By C. T. KINGZETT, F.I.C., F.C.S.

In course of some correspondence which appeared in this journal early in 1881, Prof. Lunge stated that he had failed on three several occasions in his attempts to prepare the crystallised calcic hypochlorite which I had isolated (*Journ. Chem. Soc.*, 1875, pp. 405-410) in 1875, but that he would make a further endeavour to obtain the substance by minutely observing my prescriptions, and would publish the results. Shortly afterwards, Mr. Robert Frost, of the Owens College, Manchester, addressed a letter to me, in which he said that at the suggestion of Prof. Roscoe he had undertaken to repeat my experiments, but that so far he also had failed to obtain the crystallised hypochlorite. I was thus led to examine a large number of samples of bleaching-powder, and in no case did I experience any difficulty in obtaining my original compound. Moreover, after the lapse of a few days Mr. Frost kindly wrote me a second letter stating that in the interval he had "succeeded in obtaining a large crop of the crystals with the greatest ease." He had not waited sufficiently long before first writing to me. I now venture to ask Professor Lunge, through your columns, if his final attempt to prepare the crystals was successful.

THE OXIDATION OF TERPENES.

By C. T. KINGZETT, F.I.C., F.C.S.

In the August number of the *Journal of the Chemical Society* there appears an abstract of a paper which will be found in the *Journal of the Russian Chemical Society* for April last entitled "Formation of Hydrogen Dioxide by the Oxidation of Terpenes," by W. Radulowitsch. This paper contains nothing that was not previously well known, and it amounts in substance to the fact that the author has detected peroxide of hydrogen in the solution, of which during the past few years very large quantities have been prepared for commercial purposes under my personal supervision. Incidentally I may mention that the methods employed by him to quantitatively determine the peroxide of hydrogen are not reliable. Particularly unreliable is the colorimetric method based upon the intensity of the blue colour of the chromium peroxide, because the other constituents influence the reaction.

The author certainly refers to one or more of my contributions to the chemical history of the oxidation of the terpenes, but says that his own results were published in Russian in 1869, thus making a sort of claim of priority. Considering the time and labour I have devoted to this subject, and bearing in mind the entire results of my investigations, and the narrow limit of the observations made by W. Radulowitsch, I must protest against this claim as both ill-judged and ill-timed; but if he really thinks he has been wronged in any way, I would suggest that he should translate his 1869 paper and obtain its insertion in some English journal, to enable English chemists to decide to what extent he is entitled to the credit that has been hitherto accorded to me.

It is perhaps desirable for me to state that this is the first occasion upon which I have met with the name and writings of M. Radulowitsch.

Singular Behaviour of Copper and Lead Salts with Soda-Lye.—If a solution of copper nitrate is mixed with lead acetate (neutral or basic), and if soda-lye is then added till the precipitate first formed is re-dissolved, and the mixture is boiled, the solution instead of depositing black-brown copper oxide becomes clearer and clearer. This phenomenon occurs even in dilute solutions.—*Ber. Oesterr. Ind. Gesell.* and *Chemiker Zeitung.*

HYDROCARBONS OF FORMULA $(C_5H_8)n$.*

By W. A. TILDEN, D.Sc., F.R.S.

Some time ago, in a paper read before the Chemical Society of London, I pointed out that the liquid terpenes and citrenes ($C_{10}H_{16}$) cannot be correctly represented as dihydrides of common cymene possessing the constitution usually ascribed to aromatic compounds. The hydrocarbons of the formula C_5H_8 deserve more attention than they have hitherto received, as they appear to supply important evidence in connection with this question.

The most interesting of these compounds is isoprene, a very volatile liquid discovered by Greville Williams among the products of the destructive distillation of india-rubber. It has been further studied by G. Bouchardat with very interesting results.

Isoprene is said to boil at 37° to 38°, though, according to my own observations, its boiling-point is about 3° lower. Its vapour density has been determined, and agrees with the formula C_5H_8. The bromide of isoprene has not hitherto been described, owing to the difficulty of making it. By careful management, however, I have succeeded in preparing and analysing this substance, and I find that it has the composition of a tetra-bromide, $C_5H_8Br_4$. It is a somewhat oily yellowish liquid, which cannot be distilled without decomposition, and it remains liquid at −18°.

Bouchardat has found that when isoprene is heated to about 280° for some hours, it polymerises into a terpene, which he calls di-isoprene, $C_{10}H_{16}$, together with colophene. This terpene boils at 174° to 176°, and appears to be identical with terpilene, the optically inactive hydrocarbon obtained from turpentine. It yields the same dihydrochloride, and by the action of dilute acid may be converted into terpin, $C_{10}H_{22}O_3$, crystallising in the same form as the terpin from common turpentine. I have repeated some of these experiments, and have satisfied myself of the general correctness of the statements in the papers of M. Bouchardat. When subjected to the action of sulphuric acid, isoprene behaves in precisely the same manner as turpentine oil, yielding a terpene and a fluorescent colophene. Isoprene also combines with hydracids like turpentine, and absorbs oxygen rapidly from the air. By the action of dilute solution of chromic acid isoprene is oxidised into carbonic, formic, and acetic acids. When treated with nitric acid it yields a considerable quantity of oxalic acid.

Isoprene presents two characters which distinguish it from the terpenes. One is the peculiar explosive property of the white syrupy substance, which results from its oxidation by air. The other peculiarity—its conversion into true india-rubber or caoutchouc when brought into contact with certain chemical agents, for example, strong aqueous hydrochloric acid as noticed by Bouchardat, or nitrosyl-chloride as observed by myself. It is this character of isoprene which gives it a somewhat practical interest, for if it were possible to obtain this hydrocarbon from some other and more accessible source, the synthetical production of india-rubber could be accomplished.

Since isoprene is converted into a true turpentine by heat, I thought it just possible that by the same agency turpentine might be partly depolymerised into isoprene. When turpentine is passed through a red-hot iron tube and the product fractionally distilled, a small quantity of a liquid is actually obtained, having the same composition and some of the properties of isoprene. It boils at about 37°, and its vapour density by Hofmann's method was found to be 35. The formula C_5H_8 requires 34. By the action of concentrated hydrochloric acid it yields a tough substance closely resembling caoutchouc. The small quantity at present in my possession does not enable me to pronounce positively that this liquid is isoprene, but it seems very probable. A litre of turpentine gave about

* Read before the British Association, Southampton Meeting Section B, 1882.

20 c.c. of the fraction from 37° to 40°, or thereabouts. I am engaged in the preparation of a larger quantity, and in the investigation of the somewhat complex series of hydrocarbons which are formed at the same time. This investigation has already been undertaken by Schultz (*Berichte Deut. Chem. Ges.*, x., 114), who found benzene, toluene, metaxylene, naphthalene, anthracene, methyl-anthracene, and phenanthrene, but nothing of lower boiling-point than benzene.

The hydrocarbon, valerylene, prepared by Reboul from amylene dibromide, and the piperylene obtained by Hofmann (*Berichte*, xiv., 664) in the distillation of trimethyl-piperyl-ammonium hydroxide, are both isomeric with isoprene. So far as at present is known, piperylene differs from valerylene in forming a crystalline tetra-bromide. Isoprene is, I find, unaffected by digestion with mercuric bromide and water, reagents which, according to Kutscheroff (*Berichte*, xiv., 1540*b*), convert valerylene into a ketone, $C_5H_{10}O$.

These are not the only compounds of formula C_5H_8. Theoretically there should be eight of them, assnming that the formulæ are all open chains. They are as follows:—

Propyl-acetylene, $(C_3H_7)C \equiv CH$
Isopropyl-acetylene, $(CH_3)_2CHC \equiv CH$
Methyl-ethyl-acetylene, $CH_3C \equiv CC_2H_5$

Ethyl-allene, $C_2H_5HC=C=CH_2$
α-dimethyl-allene, $CH_3HC=C=CHCH_3$
β-dimethyl-allene, $(CH_3)_2C=C=CH_2$

α-methyl-crotonylene, $CH_3HC=CH-CH=CH_2$
β-methyl-crotonylene, $CH_2=CCH_3-CH=CH_2$

The first three of these compounds seem to have been prepared and identified. They are sharply distinguished from valerylene and isoprene by giving metallic derivatives with copper and silver solutions. From the ready conversion of valerylene into the ketone it probably has the constitution of one of the dimethyl-allenes. Isoprene does not undergo this change, and I incline to the belief that it is β-methyl-crotonylene.

On looking at these formulæ it is difficult to explain by any reasonable hypothesis how either of these compounds could be readily polymerised so as to yield a methyl propyl derivative of benzene such as the terpenes, according to the ordinary hypothesis, are supposed to be. But the condensation of two molecules of β-methyl-crotonylene into one of terpene is not difficult to imagine if my formulæ are adopted. Thus—

$$CH_2=CCH_3-CH=CH_2$$
$$+CH_2=CH-CCH_3=CH_2$$

become—

$$\begin{array}{l} CH=CCH_3-CH=CH_2 \\ | \\ CH=CH-[CH(CH_3)_2] \\ \qquad\qquad \text{Isopropyl} \end{array}$$

or—

$$CH_2=C.CH_3-CH=CH_2$$
$$+CH_2=CH-CCH_3=CH_2$$

become—

$$\begin{array}{l} [CH_3-CHCH_3]-C=CH_2 \\ \text{Isopropyl} \qquad\quad | \\ \qquad\qquad\quad CH=CH-CCH_3=CH_2 \end{array}$$

These are the formulæ I gave in the paper referred to for two of the three classes of terpenes.

From what I have seen of isoprene I am disposed to look upon it as the first term of a series somewhat analogous to the olefines.

$$C_5H_8$$
$$(C_5H_8)_2=C_{10}H_{16}$$
$$(C_5H_8)_3=C_{15}H_{24}$$
$$(C_5H_8)_4=C_{20}H_{32}$$
$$\text{\&c.} \qquad \text{\&c.}$$

The terpenes therefore must be regarded as peculiar hydrocarbons, of which there are no true homologues. Certainly, at present, none are known.

The colophene from turpentine appears to be a saturated hydrocarbon of this form, for it does not unite with hydrochloric acid or bromine, though it is gradually attacked by the latter reagent with evolution of hydrobromic acid.

The absorption spectrum of isoprene appears to be peculiar. At the ultra-red end it is pronounced by Capt. Abney to possess the characteristics of an aromatic body, though inasmuch as it contains only C_5, it is manifestly impossible to regard it as a derivative of benzene. At the other end of the spectrum Prof. Hartley says it has none of the characteristics of the benzene nucleus, but a striking resemblance to Australene, that is to the hydrocarbon of which common turpentine mainly consists.

PROCESS OF MM. BLAS AND MIEST FOR THE ECONOMIC EXTRACTION OF THE PRECIOUS METALS FROM ALL KINDS OF ORES BY ELECTROLYSIS.

THE authors have discovered that if in electrolysis we replace the metal of the anode by compressed sulphur-ores these may themselves serve as an anode. Further, if we place such anodes in a bath of a suitable electrolytic salt having the same metallic base as the metal of the ore, and if we let the electric current act in such a bath, the effect is that all the sulphur of the ore is precipitated upon the anode and falls to the bottom of the bath. At the same time there is formed at the cathode a precipitate or continuous deposit of metal liberated from the salt of which the electrolytic bath consists. The acid of the bath being set free appropriates an equivalent proportion of the metal contained in the ore placed at the anode. In this manner the neutral electrolytic bath is re-constituted without ceasing and serves indefinitely.

Electrolysis of Various Sulphuretted Ores.—For simple sulphides, without gangue, containing only sulphur and a single metal, is exceedingly easy and complete. If we have an electrolytic bath containing a soluble salt of the same base, *e.g.*, a bath of lead nitrate, in case of the treatment of pure galena, this ore is placed at the anode, when under the action of the electric current the sulphur is deposited at the anode and the lead at the cathode. If the ore contains in addition to the metal a siliceous gangue, the silica is deposited at the anode at the same time with the sulphur. But these two substances though mixed together remain distinct. They fall in part to the bottom of the bath, and it is advisable to remove the rest from the anodes by an automatic brushing.

If there are antimony and arsenic in the ore, which are also precipitated at the anode, but chiefly in the state of insoluble oxides, mixed, but not combined together, nothing is easier than to separate them again by electrolysis.

In case of ores containing exceptionally much arsenic, a part of this during precipitation at the anode combines with sulphur, producing arsenic bisulphide or realgar and the yellow sulphide or orpiment.

These products are extracted and purified at first by sulphuret of carbon and afterwards by separate electrolysis in a bath with a feeble electric current, when they yield pure sulphur at the anode and oxides of arsenic and antimony at the cathode.

If we operate electrolytically on sulphides containing several metals, those of the precious metals contained in the sulphur ores, being the most easily precipitated, are thrown down first in the metallic state at the cathode, under the action of a moderate current, and consequently the electrolytic bath is regenerated without ceasing. There is merely one further operation, that of separating afterwards those of the metals which have been thrown down together

at the cathode. But this final separation requires very little electric force, because this mass of metals, already previously reduced to the metallic state and purified, when they are placed together in another electrolytic bath and are dissolved there under the action of the electric current, regenerate the thermic force or thermic work necessary for the ulterior precipitation of each metal separately, saving the slight unimportant and inevitable losses of thermic or electric action.

We extract first the sulphur of carbon disulphide used, with or without pressure. Carbon disulphide dissolves and removes promptly that part of the mixed sulphur which is combined neither with silica nor iron.

On re-distilling the decanted carbon disulphide loaded with dissolved sulphur, the latter is deposited in a state of purity.

If the electrolysed ore is a multiple sulphide, containing especially much iron, we obtain then at the first operation sulphur and iron oxide. If in place of then separating these two bodies by one of the methods described above, we electrolyse them feebly a second time in a bath composed, *e.g.*, of dilute sulphuric acid, we obtain then pure sulphur at the anode, and iron as a basic sulphate at the cathode. But sulphate of iron is in regular demand and of great use in industry. We may otherwise electrolyse it again or use it as an electrolytic salt for the extraction of iron.

In separating the mixture of sulphur and iron oxide there is no outlay of work or of thermic power. On the contrary, in this operation there is production of heat, and consequently of work.

Practically, 1½ horse-power is required to produce electrolytically in one hour one kilogramme of copper set free from a sulphuretted copper ore, a wonderful result in point of economy.

Electrolysis of Complex Ores.—The same process is equally applicable to the extraction of the metals contained in the multiple sulphurets. Such sulphurets are in reality merely combinations of single sulphides combined or mixed together; consequently the decomposition of such a multiple ore in the electrolytic bath, instead of yielding merely a single metal to the acid which is set free, precipitates the precious metals which the ore contains.

Thus, if we place at the anode in an electrolytic trough an ore composed of a multiple sulphuret and make use of a solution of lead nitrate as the electrolytic liquid and let the current act moderately, it will happen that whilst the lead of the electrolytic salt is precipitated at the cathode the metals of the ore placed at the anode will enter into solution simultaneously just in proportion as the acid of the bath is set free, and will ultimately, if easily precipitable, like lead, silver, copper, &c., be thrown down together at the cathode.

Meanwhile the sulphur, the silica, and other insoluble matter in the gangue will be deposited at the anode.

Suppose that we operate upon a multiple argentiferous sulphide of lead, the ore of which contains also iron, copper, and zinc. It may happen that under the action of an electric current sufficiently energetic the iron and zinc dissolve as rapidly as the other metals, but are not as easily precipitated. In this case the electrolytic solution will become gradually saturated with zinc and iron. It is then advisable to regulate the galvanic current so that the lead, silver, gold, and copper may be precipitated alone upon the cathode, keeping the zinc dissolved in the state of zinc nitrate.

As the bath becomes saturated with zinc nitrate, the iron nitrate yields the precedence, and its base falls to the bottom of the bath in the state of ferric oxide.

Finally, when the bath is almost entirely saturated with zinc nitrate, which is kept in a state non-precipitable by regulating the current accordingly, this solution of zinc is syphoned off for separate treatment.

The opportunity is taken to remove the metals, copper, lead, silver, and gold, which have been thrown down upon the cathode in the metallic state. The ferric oxide at the bottom of the bath is withdrawn separately, and also the sulphur and the silica found at the anode.

The method of ulterior purification of the sulphur is given above.

The metallic zinc contained in the liquid syphoned off may then be precipitated by a more powerful current. If it is desired to collect the zinc in the state of oxide it must be precipitated not electrolytically but by means of chemical reactions.

This separate zinc-bath is treated first with a little zinc oxide, which throws down any iron present in the state of insoluble oxide. Then, if needful, the liquid is placed in a precipitation bath with a zinc plate for anode. A feeble electric current will throw down upon this cathode all the lead, copper, or silver which the bath may retain, leaving merely pure zinc nitrate.—*Les Mondes.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 7, August 14, 1882.

Appearance of Manganese on the Surface of Rocks.—M. Boussingault.—A long and discursive paper, in which the author quotes largely from Humboldt on the junction between the Amazon and the Orinoco; he refers to the local tradition that the denuded rocks, especially those of granite, are unsafe to encamp or sleep upon. He finds that the black incrustation met with on rocks occasionally submerged in the rivers consists of a dolomite in which manganese carbonate is substituted to a great extent for magnesium carbonate, and is superficially converted into peroxide by exposure to the air. He has detected manganese in the waters of this region.

A New Process for Insulating Electric Wires.—H. Geoffroy.—The author covers the wires with asbestos, and places them then in a tube of lead.

Hydro-dynamic Experiments: an Imitation by means of Liquid of Gaseous Currents of the Magnetic Phantoms obtained with Electric Currents or with Magnets.—C. Decharme.—The author gives instructions for imitating hydro-dynamically the lines of force of an electric current in a plane perpendicular to its direction, or, again, in a plane parallel to its direction; the lines of force of two currents in the same direction, or in opposite directions, and in planes perpendicular to their directions. The large magnetic phantoms produced by magnets, single or combined, are produced in a very similar manner.

Surface-Tension of certain Liquids in Contact with Carbonic Acid.—S. Wroblewski.—The decrease of the surface-tension of the liquid depends solely on the fact that the surface-tension of the liquids with which they are compressed is extremely small.

Certain Arseniates Neutral to Litmus Paper.—MM. Filhol and Senderens.—The authors have obtained a sesquisodic arseniate, but have not found it possible to obtain the corresponding potassium and ammonium salts. They have prepared, however, two double arseniates,—the sodium-ammonium and sodium-potassium salts. The stability of the new phosphates (see *Comptes Rendus*, xciv., p. 449) and arseniates increases with the number of molecules of crystalline water which enters into their composition.

Fermentation of Starch. Presence of a Vibrio in the Grain of Maize during Germination and in the Stem of the Plant.—V. Marcano.—The author finds that the fermentation of chicha, an alcoholic drink pre-

pared from pounded maize, is due to the reproduction in it of a well-characterised organism, which assumes in its development three forms; vibrios, globules with a nucleus like those of yeast and mycelian tubes, from which the vibrios escape at a certain moment.

Cosmos Les Mondes.
No. 15, August 12, 1882.

Dissociation of Copper Sulphate.—D. Tommasi and E. Pegna.—A solution of chemically pure copper sulphate, if boiled, deposits a pale green powder of basic sulphate. The authors have undertaken to determine the quantity of basic sulphate formed with reference to the dilution of the cupric solution. From a 1 per cent solution containing 15 grms. of the sulphate, after boiling for six hours, the quantity of the basic salt obtained was 0·380 grm. The filtrate was boiled again for three hours, and scarcely became turbid. On being again re-heated it grew turbid again, but the turbidity disappeared on stirring. The quantity of the basic sulphate formed increases with the concentration of the solution. The precipitate obtained is also the more basic as the concentration is increased.

No. 16, August 19, 1882.

On Succinine.—Succinic acid, if allowed to act upon glycerin at 200°, forms the succinic ether of glycerin, which Van Bemmelen names succinine. The composition of this body is $C_7H_{10}O_5$. It is insoluble in cold water, but is decomposed on prolonged contact. It is soluble in hot water and hot alcohol, but not in ether, chloroform, benzol, and carbon disulphide.

Revue Universelle des Mines, de la Metallurgie, &c.,
No. 3, May and June, 1882.

This issue contains no chemical matter.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 5.

The Distribution of Heat and Rain during the Growth of the Sugar-Beet.—H. Briem.—A memoir of local interest.

Impoverishment of the Soil by the Removal of Leaves, Twigs, &c., in Woods.—Dr. Hanamann.—This practice deprives the soil of the matter which should be returned to it by the decomposition of the fallen leaves, &c., and makes it unable to retain a sufficient quantity of moisture.

Contributions to the Agronomic Examination of Soils.—Dr. M. Fesca.—The author admits that the chemical and physical properties of an arable soil as determined in the laboratory do not generally allow of a conclusion as to its culture-value. The reason of this must be sought in our imperfect knowledge of the properties and effects of the constituents of the soil. In the present memoir he discusses the value and the means of determining the coefficients of absorption. Absorption depends on chemical changes, which are especially caused by the zeolites (easily soluble silicates) present in the soil. Hence the author views the phenomena of absorption as special phases of the process of weathering. By this term we must understand not merely the physical and chemical destruction of the minerals, but—what is almost more important for the formation of soils—the processes of the transformation of minerals.

Manurial Experiments on the Action of Natural Phosphates.—L. Guillaume.—The author concludes that the application of undissolved phosphates to poor soils is of little value. The application of phosphorite to the sandy soils of Naraucourt in the Ardennes gave increased crops, but the improvement did not cover the outlay. The number of diseased potatoes was smallest in plots manured with phosphorite alone, larger where a mixture of phosphorite and farm-yard dung was used, and largest with the latter alone.

Manufacture of Saltpetre from the Salts of the Osmose Water derived from the Treatment of Treacle,—Marquis d'Havringcourt.—This process frees sugar-works from a troublesome by-product and leaves a valuable saleable article.

Dung of Deep Stalls.—Dr. A. Emmerling and G. Loges.—Dung which remains for a length of time in deep stalls and is trodden down by the animals and kept moist by their liquid excrements is preserved better, especially as regards its percentage of nitrogen, than that kept in a manure heap. The author, however, concludes that the percentage of effective matter is substantially the same in both.

Manurial Experiments on the Experimental Field of the Agricultural School of Norden.—Dr. Wegner.—According to the results artificial manures can be profitably applied on marsh-lands.

Manurial Results with Osmose Water.—H. Briem.—In experiments with beets the quantity of the crop was greatly increased, but the quality was so deteriorated that the use of this water cannot be recommended. The addition of concentrated osmose water to compost heaps produces a remarkable acceleration of the decomposition of organic matter.

Manurial Experiments with Different Phosphates on the Trial Field of the "Station Agronomique" of Nancy.—L. Grandeau.—In these experiments, precipitated phosphate was found of equal value with superphosphate for equal quantities of phosphoric acid. Bone-meal was worst (possibly from the sparing solubility of its nitrogen, whilst readily soluble nitrates or ammonium salts were added to the other phosphates), whilst phosphorite fell little short of the first-named phosphates. These conclusions apply to light, poor soils, and might require to be modified on land of another quality. Manures containing only potash and phosphoric acid increased the yield by 11·3 per cent as compared with unmanured plots; manures containing in addition nitrogen gave an increase of 40 per cent. It is calculated that the total value of the excreta (human and brute) produced in France, in nitrogen, phosphorus, and potash, is 3½ milliards yearly.

Signification of Asparagine in Animal Nutrition.—Prof. H. Weiske.—Asparagine has a certain value for the nutrition of the herbivora.

Preservation of the Power of Germination in Sprouted Corn.—A. E. Ehrhardt.—Sprouting alone does not necessarily render a second permanent germination impossible.

Aldehyd-like Substances in Chloro-phyllaceous Plant Cells.—Prof. J. Reinke.—From the *Berichte.*

Aldehydic Nature of Living Protoplasm.—O. Loew and T. Bokorny.—A reply to the foregoing paper.

Researches on the Inner Causes of Growth and on their Artificial Modifications.—Dr. K. Kraus.—Experiments on the effect of drying bulbs before planting, on the removal of leaves, on soaking seed before planting, and on heaping up soil over the crown of roots.

Detection of Magenta, Orchil, and Cudbear in Wine.—Dr. B. Haas.—These colours are not suitable for converting white wine into red, but they can be used for giving wines a faint red tint; for darkening pale red wines and in making up a factitious bouquet essence which is added to red wines. The most suitable methods for the detection of magenta are those given by Roméi and Falières-Ritter. If a wine coloured with orchil and one coloured with cudbear are treated according to Roméi's method, the former gives, with basic lead acetate, a blue, and the latter a fine violet precipitate. The filtrate, if shaken up with amylic alcohol, gives it in either case a

red colour. A knowledge of this fact is important, or it may be mistaken for magenta. The behaviour of the amylic alcohol, thus coloured red, with hydrochloric acid and ammonia is characteristic. If the red colour is due to magenta it is destroyed by both these reagents, whilst hydrochloric acid does not decolourise the solutions of orchil and cudbear, and ammonia turns their red colour to a purple violet. If the wine is examined according to the Falières-Ritter method in presence of magenta, ether, when shaken up with the wine, previously rendered ammoniacal, remains colourless, whilst if orchil or cudbear is present the ether is coloured red. Wartha has made a convenient modification in the Falières-Ritter method by adding ammonia and ether to the concentrated wine while still warm. If the red colour of the wool is due to orchil or cudbear it is extracted by hydrochloric acid, which is coloured red. Ammonia turns the colour to a purple-violet. König mixed 50 c.c. wine with ammonia in slight excess, and places in the mixture about ½ grm. clean white woollen yarn. The whole is then boiled in a flask until all the alcohol and the excess of ammonia are driven off. The wool taken out of the liquid and purified by washing in water and wringing is moistened in a test-tube with pure potassa lye at 10 per cent. It is carefully heated till the wool is completely dissolved, and the solution when cold is mixed first with half its volume of pure alcohol, upon which is carefully poured the same volume of ether, and the whole is shaken. The stratum of ether decanted off is mixed in a test-tube with a drop of acetic acid. A red colour appears if the slightest trace of magenta is present. The shaking must not be too violent lest an emulsion should be formed. If the wine is coloured with orchil, on prolonged heating, after the addition of ammonia, it is decolourised. If it is then let cool and shaken a little, the red colour returns. If the wool is taken out of the hot liquid after the red colour has disappeared and exposed to the air, it takes a red colour. But if it is quickly taken out of the liquid and at once washed, there remains merely a trace of colour in the wool. If these precautions are observed, magenta can be distinguished from orchil with certainty according to König's method. As the colouring-matter of orchil is not precipitated by baryta and magnesia, but changed to a purple, the baryta method recommended by Pasteur, Balard, and Wurtz, and the magnesia test, are useless. In conclusion the author shows that magenta may in course of time be removed by the precipitates formed in the wine. It is therefore necessary to test not merely the clear liquid, but the sediment, if any.

Preservation of Must by means of Salicylic Acid.—Dr. J. Bersch.—The author finds that 15/200,000 of salicylic acid entirely prevent the formation of mould.

Scherff's Milk.—Dr. B. Martiny.—New milk without any addition is put into glass bottles, stoppered, and then heated by steam for one to two hours to from 100° to 120° under a pressure of from 2 to 4 atmospheres. The milk is thus not merely rendered capable of preservation for an unlimited time, but the caseine is peptonised, so that in contact with the gastric juice it is converted in fine easily divisible and digestible flocks, as in the milk of a not-ruminant animal. The virus of foot-and-mouth disease, tuberculosis, &c., is destroyed.

In what Period of Vegetation is the Chief Activity of Potassium Compounds in Plants?—Prof. V. Th. Magerstein.—A preliminary communication.

Journal für Praktische Chemie.
New Series. Vol. xxv., Nos. 9 and 10.

Bromine Addition-Products of the Crotonic Acids and of Methacrylic Acid.—Dr. Carl Kolbe.—The results of the author's researches are that the dibromo-butyric acids obtained from normal crotonic acid and from iso-crotonic acid by the addition of bromine, are identical, whilst an isomeric compound, dibrom-isobutyric acid, is obtained from methacrylic acid. By decomposition with water or with sodium carbonate we obtain from dibrom-isobutyric acid acetone together with a little propionyl-aldehyd brom-methacrylic acid and brom-oxy-isobutyric acid, whilst the corresponding products of normal dibrom-butyric acid are mono-brom-propylene, oxy-brom-butyric acid, and dioxy-butyric acid. By treatment with soda-lye hydrobromic acid is withdrawn both from normal dibromo- and from dibrom-isobutyric acid, with formation respectively of bromo-crotonic and of brom-methacrylic acids.

Contributions to the Chemistry of the Chrom-ammoniacal Compounds.—S. M. Jörgensen.—In this memoir (which is a continuation from p. 321 of the present volume of this *Journal*) the author describes the normal and basic erythro-chromates, and discusses the theory and formation of the chrom-ammonium salts.

Arsenic Sulphide in Aqueous Solution.—H. Schulze.—The author seggests that in addition to the absolutely insoluble arsen-trisulphide, there exists a second modification of this compound, soluble in water.

MISCELLANEOUS.

New Substitutes for Bone-black.—Dr. A. v. Wachtel and E. A. Schott.—Stranecky's substitute is a mineral consisting of silica, ferric, aluminium, and magnesium oxides, repeatedly saturated with molasses, dried, and ignited. The finished product, which contains 3 per cent of carbon, is less adapted for removing colour than alkali from saccharine juices. Schott's substitute is obtained by re-charring a peat-charcoal along with fat coal.—*Biedermann's Centralblatt.*

Preparation and Quantitative Determination of Tellurium.—Crude tellurium is oxidised in heat with nitric acid, mixed with water, boiled up, and set aside for twenty-four hours. During this time most of the tellurium separates out as tellurous acid. This, together with the sand, is filtered off, dissolved in hydrochloric acid, precipitated with sulphurous acid, the separated tellurium extracted with concentrated hydrochloric acid, filtered, and dried. The filtrate is further treated with sulphurous acid, and the impure tellurium separated out is treated further like crude tellurium. The tellurium thus obtained is pure enough for most purposes, but if a chemically pure tellurium is required it must be distilled in a current of hydrogen.—*Annalen der Chemie und Pharmacie* and *Chemiker Zeitung.*

ERRATA.—Vol. xlv., p. 216, col. 2, in table headed "Elementary," *insert* "Chromium, 0·28." In table headed "With the oxygen distributed," *for* "Iron monoxide, 8·64," *read* "8·84."

UNIVERSITY COLLEGE, LONDON.

FACULTY of SCIENCE, includ the Departments of ENGINEERING and CHEMICAL an MECHANICAL TECHNOLOGY

The SESSIO will OPEN on Tuesday, October 3rd.

For detailed Prospectuses of the Courses of Instruction, Exhibitions, Scholarships, &c., apply to the College, Gower-street, W.C.

TALFOURD ELY, M.A., Secretary.

UNIVERSITY COLLEGE, BRISTOL.

PROFESSOR—W. RAMSAY, Ph.D.
LECTURER—SYDNEY YOUNG, D.Sc.

Lectures on Inorganic, Organic, and Technical Chemistry will be given during the Session, beginning October 9th. The Laboratories are fitted with the most recent improvements for the study of Practical Chemistry in all its branches. There are in the evening Lectures on Inorganic Chemistry, and a Class for Practical Chemistry, both at reduced fees. Calendar price 6d., by post 8d.

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J. N. LANGLEY, LL.D., Registrar and Secretary.

THE CHEMICAL NEWS.

Vol. XLVI. No. 1191.

ADDRESS TO STUDENTS.

Taking up a subject which we slightly touched upon a year ago, we venture to call the attention of students in chemistry to a consideration which is too much left out of sight at the present day. It has been, perhaps, too much the fashion among those who have urged the claims of chemistry to rank as an important part of higher education to dwell exclusively upon its practical utility, upon its extensive and increasing applications. They have pointed out that, whilst in a majority of cases a knowledge of the classics or of history neither enables a man to get on in the world nor to get the world on, a knowledge of chemistry does both. Perhaps, to look at the claims of chemistry, and of the physical sciences in general, was essential in order to win the suffrages of the utilitarian portion of mankind, whose sole question concerning any and everything is its immediate market-value. But, by going a little too far, the friends of chemical science, just in proportion as they conciliated one class of opponents, played into the hands of another. The supporters of the old educational school contended that the chief value of any study lies not so much in the facts which it communicates, as in the mental discipline which it imparts. They urged that the attention given to the classics was a kind of mental gymnastics, which, even if of no direct utility, rendered the mind fitted for every sphere and every duty of life. Now, in the first part of their contention, viz., that mental training is of more value and importance than the mere amassing of what is commonly called information, these authorities were decidedly right. "Method," as Auguste Comte terms it, ranks higher than "doctrine." But they are utterly wrong in supposing that classical studies were either the only or even the best agency for acquiring mental discipline. This truth—possibly unpalatable to many—will at once appear if we reflect that classical and, for the matter of that, mathematical studies also are utterly powerless to teach the art of observation. They do not habituate students to take in at once, accurately and completely, the attributes of any object placed before them, such as its size, its weight, its colour, texture, hardness, &c., and its relations to and behaviour with other objects. It is true a man may be a born, or a hereditary observer—whose faculties require no special educational training. But such a man is one amongst, perhaps, a hundred thousand. The great majority of men do not and cannot observe either objects or events correctly without they have gone through a systematic training. This training can best be obtained by the careful study of physics, chemistry, or biology, chemistry being, if anything, the most convenient study for the purpose.

Again, how, except by the study of some one of the physical sciences, can a man learn the most important and delicate art of experimentation, that is, of putting definite questions to Nature? It is simply and absolutely impossible.

But we may go further: The dominant part played by classical studies, or, more comprehensively speaking, by literature, in our national system of education, not merely fails to teach the student the two grand arts of observation and experiment; it formally, if we may use the expression, *un*teaches them and crowds them out. This it does by fixing the attention exclusively on words, to the neglect of things. The word-monger sees the world only through the medium of paper,—a very dim and opaque one at the best.

Furthermore, physical science not merely teaches us the arts of observation and experiment; it gives the best training in the art of co-ordinating and explaining the phenomena which we have observed or elicited. It shows us how to frame provisional theories, how to bring them to the test, and how to modify them so as to be a gradually more and more complete approximation to the truth. Now in these processes the mere logician, and even the mere mathematician, unless also trained in the physical or natural disciplines, generally fall into egregious errors. The logician may argue correctly, but he does not and cannot test his premisses. The mathematician lays down formidable arrays of formulæ, but he too often quietly begs the question in such words as "if we only assume," "if we then suppose," "let it be granted," and the like, when in too many cases there is no right to assume, suppose, or grant anything of the kind.

It has been said that almost the whole business of life may be resolved into drawing right conclusions from facts correctly observed. If this be the case, chemistry, as teaching the arts of observing and interpreting phenomena, must be of incalculable educational value, not merely to those who devote their lives to research, not merely to those who find in it a professional or a trade interest, but to the great mass of the public.

We have often permitted ourselves to dream of a type of education, based from the very outset on a systematic culture of the perceptive powers; where the pupil, instead of, as now, learning from books and occasionally referring to things by way of illustration, should learn from things and refer to books by way of recapitulation and extension. In such a system, chemistry would play a most important part. Of course it would require to be taught in a manner somewhat heterodox, beginning, not with abstractions, names, symbols, calculations, and theories, to be taken on faith, but with the concrete phase of the science.

One thing we admit the study of the natural sciences cannot effect—it will not teach the art of expression. But if the world gets wiser, it will set less and less value on this art. It will feel more indebted to the man who tells it some new truth in the simplest language rather than to the orator or the novelist, who clothes the most threadbare or the most deceptive ideas in ornate and seductive language.

Researches on the Physical Properties of the Soil in a Dense and a Loose State.—Prof. E. Wollny.—Density of soil is to be aimed at when it is desired to increase the proportion of water in the soil, and a loose condition should be maintained where the contrary state is found needful. The more densely the particles of the soil are aggregated together, the more such soil will vary in temperature.—*Biedermann's Centralblatt.*

UNIVERSITIES AND COLLEGES.

UNIVERSITY OF LONDON.

Candidates for any Degree granted by this University are required to have passed the Matriculation Examination, to which no candidate is admitted unless he has produced a certificate showing that he has completed his sixteenth year.

The Fee for this examination is £2.

The Examination will be held on Monday, January 8th, 1883. It is conducted by means of Printed Papers; but the Examiners are not precluded from putting, for the purpose of ascertaining the competence of the Candidates to pass, *viva voce* questions to any Candidate in the subjects in which they are appointed to examine.

Candidates are not approved by the Examiners unless they have shown a competent knowledge in each of the following subjects:—Latin. Any two of the following Languages:—Greek, French, German, and either Sanskrit or Arabic. The English Language, English History, and Modern Geography. Mathematics. Natural Philosophy. Chemistry.

The Examination in Chemistry is—Chemistry of the Non-metallic Elements; including their compounds—their chief physical and chemical characters—their preparation—and their characteristic tests.

A Pass Certificate, signed by the Registrar, will be delivered to each Candidate who applies for it, after the Report of the Examiners has been approved by the Senate.

If in the opinion of the Examiners any Candidates in the Honours Division of not more than Twenty years of age at the commencement of the Examination possess sufficient merit, the first among such Candidates will receive an Exhibition of thirty pounds per annum for the next two years; the second among such Candidates will receive an Exhibition of twenty pounds per annum for the next two years; and the third will receive an Exhibition of fifteen pounds per annum for the next two years; such exhibitions are payable in quarterly instalments, provided that on receiving each instalment the Exhibitioner declares his intention of presenting himself either at the two Examinations for B.A., or at the two Examinations for B.Sc., or at the Intermediate Examination in Laws, or at the Preliminary Scientific M.B. Examination, and Intermediate Examination in Medicine, within three academical years from the time of his passing the Matriculation Examination.

Under the same circumstances, the fourth among such Candidates will receive a prize to the value of ten pounds in books, philosophical instruments, or money; and the fifth and sixth will each receive a prize to the value of five pounds in books, philosophical instruments, or money.

Any Candidate who may obtain a place in the Honours Division at the Matriculation Examination in January is admissible to the Intermediate Examination either in Arts or in Science in the following July.

Intermediate Examination in Science.

The Intermediate Examination in Science will be held in July, 1883.

No Candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this Examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

The Examination embraces the following subjects:—Pure and Mixed Mathematics, Inorganic Chemistry, Experimental Physics, and General Biology.

Examination for Honours.

Any Candidate who has passed the Intermediate Examination in Science in all its subjects may be examined at the Honours Examination next following the Intermediate Examination in Science at which he has passed for Honours in (1) Mathematics, (2) Experimental Physics, (3) Chemistry, (4) Botany, and (5) Zoology; unless he has previously obtained the Exhibition in Pure and Mixed Mathematics at the Intermediate Examination in Arts, in which case he will not be admissible to the Examination for Honours in that subject; or unless he has previously obtained an Exhibition at the Preliminary Scientific (M.B.) Examination in either of the subjects which are common to it with the Intermediate Examination in Science, in which case he will not be admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry will be examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition, they will be examined practically in Simple Qualitative Analysis. This Examination, which will consist of six hours' examination by printed papers and of six hours' practical work, will take place on Thursday and Friday (with Saturday if necessary) in the same week with the Examination for Honours in Mathematics, commencing on each day at 10 a.m.

In the Examination for Honours, the Candidate, not being more than 22 years of age at the commencement of the Pass Examination, who most distinguishes himself in Mathematics, will receive an Exhibition of £40 per annum for the next two years.

B.Sc. Examination.

The B.Sc. Examination will be held in October.

Candidates for this Examination are required to have passed the Intermediate Examination in Science at least one academical year previously.

The Fee for this Examination is £5.

The regulations are framed with the view of allowing the candidate to select *any three* of the following nine subjects:—

1. Pure Mathematics.
2. Mixed Mathematics.
3. Experimental Physics.
4. Chemistry.
5. Botany, including Vegetable Physiology.
6. Zoology.
7. Animal Physiology.
8. Physical Geography and Geology.
9. Mental and Moral Science.

Examination for Honours.

Any Candidate who has passed the B.Sc. Examination, and has not previously passed the B.A. Examination, may be examined at the Honours Examination next following the B.Sc. Examination at which he has passed, for Honours in (1) Mathematics, (2) Mental and Moral Science, (3) Experimental Physics, (4) Chemistry, (5) Botany, (6) Zoology, (7) Physiology, (8) Physical Geography and Geology; provided that he shall have gone through the Pass Examination in the corresponding subject or subjects immediately before. And any Bachelor of Arts who has passed the B.Sc. Examination may under the same conditions be examined for Honours in one or more of the above mentioned subjects, unless he have previously obtained a Scholarship at the B.A. Examination in either of the first two of those subjects, in which case he shall not be admissible to the Examination for Honours in that subject.

The examination for Honours in Chemistry will take place on Monday and Tuesday in the week following the Examination for Honours in Mathematics; on Monday by printed papers (chiefly on Organic Chemistry), and on Tuesday by practical exercises in Simple Qualitative and Quantitative Analysis.

The candidate, being not more than 23 years of age, who most distinguishes himself in Chemistry, will receive £50 per annum for the next two years, with the style of University Scholar.

DOCTOR OF SCIENCE.

The examination for the Degree of Doctor of Science takes place annually within the first twenty-one days of June, and the examination in each branch occupies four days.

No candidate is admitted to the examination for the Degree of D.Sc. until after the expiration of two Academical Years from the time of his obtaining the Degree of B.Sc. in this University, unless he shall have passed the B.Sc. Examination in the First Division at least two Academical years subsequently to having passed the Intermediate Examination in Science, in which case he shall be admitted to the examination for the Degree of Doctor of Science at the expiration of *one* Academical Year from the time of obtaining his B.Sc. Degree.

The Fee for this Examination is £10.

Every candidate for the degree of D.Sc is examined in some one or more of the various branches of Physical, Biological, Geological and Palæontological, or Mental Science, to be selected by himself; and no candidate is approved by the examiners unless he has shown a thorough practical knowledge of the principal subject and a general acquaintance with the subsidiary subject or subjects, specified as belonging to the branch so selected. He is expected to be so fully conversant with the principal subject he may select as to be able to go through any examinational test (whether theoretical or practical) of his acquirements in it that can be fairly applied. Candidates, when giving notice, must specify the branch or branches in which they desire to be examined.

BRANCH IV. OF PHYSICAL SCIENCE. INORGANIC CHEMISTRY.

Principal Subject—Inorganic Chemistry.

Subsidiary Subjects—Either Organic Chemistry; or Mineralogy, Crystallography, and Chemical Technology in its relations to Inorganic Chemistry.

BRANCH V., ORGANIC CHEMISTRY.

Principal Subject—Organic Chemistry.

Subsidiary Subjects—Either Inorganic Chemistry; or Chemical Technology in its relations to Organic Chemistry, and the Chemistry of Animal and Vegetable Life.

PRELIMINARY SCIENTIFIC (M.B.) EXAMINATION.

This examination will be held in July, 1883.

No Candidate is admitted to this examination until he has passed the Matriculation Examination,* and notice must be given to the Registrar at least 14 days before the commencement of the examination. The fee for this examination is five pounds.

Candidates for the degree of M.B. are strongly recommended by the Senate to pass the Preliminary Scientific Examination before commencing their regular medical studies; and to devote a preliminary year to preparation for it according to the following programme:—Winter Session: Experimental Physics; Chemistry (especially Inorganic); Zoology. Summer Session: Practical Chemistry (Inorganic); Botany.

Any candidate who has passed the Preliminary Scientific (M.B.) Examination, may be examined at the Honours Examination next following the Preliminary Scientific Examination at which he has passed, unless he has previously obtained an Exhibition in any one of the subjects at the First B.Sc. Examination, in which case he is not admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry are examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition they are examined practically in Simple Qualitative Analysis.

EXAMINATION IN SUBJECTS RELATING TO PUBLIC HEALTH.

A Special Examination will be held in December in subjects relating to public health.

No candidate is admitted to this Examination unless he has passed the Second Examination for the Degree of Bachelor of Medicine in this University at least one year previously; nor unless he shall have given notice of his intention to the Registrar at least two calendar months before the commencement of the Examination.

The Fee for this Examination is £5.

GILCHRIST SCHOLARSHIPS.

1. A Scholarship of the value of Fifty Pounds per annum, and tenable for three years, is annually awarded to the Candidate from the Royal Medical College, Epsom, who at the June Matriculation Examination stands highest among the Candidates approved by the Head Master of that Institution, and who passes either in the Honours List or in the First Division; on condition of his prosecuting his studies during the tenure of his Scholarship with a view to Graduation in one of the Faculties of the University of London.—Particulars may be obtained on application to the Secretary of the Royal Medical College, 37, Soho Square, W.

2. A similar amount is annually offered to Candidates intending to pursue, at Owens College, Manchester, their studies for Graduation in one of the Faculties of the University of London; a single Scholarship of Fifty Pounds per annum for three years being awarded to the highest of those Candidates at the June Matriculation Examination who shall have been previously approved by the Principal of Owens College, provided that he pass in the Honours Division; or, in case no Candidate should so pass, two Scholarships, each of Twenty-five Pounds per annum, being awarded to the two Candidates as aforesaid who shall stand highest in the First Division.—Particulars may be obtained on application to the Principal of Owens College, Manchester.

3. A Scholarship of Fifty Pounds per annum, tenable for three years, is also annually awarded to that Candidate in the Honours Division at the June Matriculation Examination who shall stand highest of the Candidates previously approved by the Principal of University College, Bristol; and who intends to study at that College with a view to graduation in one of the Faculties of the University of London. [N.B.—This Scholarship is open to Women.] Further particulars may be obtained on application to the Principal of University College, Bristol.

Particulars of the Colonial and Indian Scholarships may be obtained on application to the Secretary of the Gilchrist Educational Trust, 4, Broad Sanctuary, Westminster, S.W.

UNIVERSITY OF OXFORD.

Waynflete Professor of Chemistry.—W. Odling, M.A., F.R.S.

Professor of Mineralogy.—N. S. Maskelyne, M.A., F.R.S.

Every Student must reside in one or other of the Colleges or Halls, or in licensed lodgings, for a period of three years, passing at least two examinations in Arts, and one in either Mathematics, Natural Science, Law, Modern History, or Theology, when, if he obtain a first, second, or third class, he can take his B.A. Degree; if he do not gain such honour he has to pass a third examination in *Literis Humanioribus*.

The fee for students working in the Laboratory for three days in the week during the Term is £3; for students working every day, £5.

Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other colleges, by competitive examination in Natural Science.

More detailed information may be obtained from the

* Candidates who pass in all the subjects of the Preliminary Scientific (M.B.) Examination, and also pass *at the same time* in the Pure Mathematics of the Intermediate Examination in Science, or who have previously passed the Intermediate Examination in Arts, are admissible to the B Sc. Examination.—One Fee of £5, paid on entering for the Preliminary Scientific Examination also admits a Candidate to the Mathematics of the Intermediate Examination in Science, *if taken at the same time.*

University Calendar; from the professors; from E. Chapman, Esq., M.A., Frewin Hall; and from the Sub-Librarian in the Radcliffe Library or the Museum.

Oxford Local Examinations.

These Examinations will commence on Monday, June 4, 1883.

Printed forms, on which Candidates are to make application, will be prepared by the 1st of March and may be obtained until Saturday, 7th of April, after which date none will be issued. The Forms for Junior and Senior Candidates are distinct.

For examination in Oxford the Forms may be obtained from G. E. Baker, Esq., Clarendon Building, Oxford.

The same Forms may be obtained from the various Local Secretaries, from whom also all other necessary information may be procured.

The Printed Forms, duly filled up, must be *returned* to the several Local Secretaries by Saturday, April 14th. No Candidate's name will be received at any place after that day. The words "Local Examinations" should be written on the covers of all letters addressed to the Secretaries.

Fees.—Every Junior Candidate is required to pay a Fee of 20s., every Senior Candidate 30s.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. D. Liveing, M.A., F.R.S.

Jacksonian Professor of Natural and Experimental Philosophy.—J. Dewar, M.A., F.R.S.

Demonstrators.—J. W. Hicks, M.A., W. J. Sell, B.A., and H. J. H. Fenton, B.A.

The Student must enter at one of the Colleges, or as a Non-collegiate Student, and keep terms for three years by residence in the University. He must pass the previous examination in Classics and Mathematics, which may be done in the first or second term of residence, or, through the Oxford and Cambridge Schools Examination Board, or through the Senior Local Examinations, before commencing residence. He may then proceed to take a Degree in Arts, either continuing mathematical and classical study, and passing the ordinary examinations for B.A., or going out in one of the Honour Triposes.

The scholarships, ranging in value from £20 to £80 a year, are chiefly given for mathematical and classical proficiency. Scholarships are given for Natural Science in Trinity, St. John's, St. Peter's, Clare, Christ's, Sidney, Pembroke, Caius, and Downing Colleges; the examinations being at Easter, and in June and October.

The Chemical Laboratory of the University is open daily for the use of the Students. The Demonstrators attend daily to give instructions.

Non-collegiate Students are allowed to attend certain of the College Lectures and all the Professors' Lectures, and have the same University status and privileges as the other Students. They are under the superintendence of the Rev. R. B. Somerset, Orford House, Cambridge, from whom further information may be obtained.

The following are the Lectures on Chemistry for the ensuing Academical Year: –

Michaelmas Term, 1882.

General Course, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Oct. 12.

Physical Chemistry (Advanced), by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Oct. 13.

Organic Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11 a.m. Begin Oct. 14.

Metals, by Mr. Pattison Muir, Caius College, Monday, Wednesday, and Friday, at 10 a.m. Begin Oct. 13.

General Principles of Chemistry, by Mr. Pattison Muir, Caius College, Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Oct. 14.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin Oct. 15.

Spectroscopic Analysis, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 1.30 p.m. Begin Oct. 19.

Practical Chemistry, by the Professor and the Demonstrators of Chemistry. University Laboratory. Also at St. John's, Caius, Sidney, and Downing Colleges. Daily. Begin Oct. 11.

Lent Term, 1883.

General Course continued, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Jan. 23.

Organic Chemistry, by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Jan. 24.

General Course of Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11 a.m. Begin Jan. 23.

Non-metallic Elements, by Mr. Pattison Muir, at Caius College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Jan. 24.

General Principles of Chemistry continued, by Mr. Pattison Muir, Caius College, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Jan. 25.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m.

Practical Chemistry, at the University Laboratory, daily. Begin Jan. 15. And at St. John's, Caius, and Sidney Colleges, daily. Begin Jan. 22.

Easter Term, 1883.

Elementary Chemistry, by a Demonstrator, on Mondays, Wednesdays, and Fridays, at 3 p.m. Begin April 16.

General Course continued, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11. Begin April 19.

Non-Metals (continued) and Organic Chemistry (Elementary), by Mr. Pattison Muir, at Caius Laboratory, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin April 18.

General Principles (continued) and Organic Chemistry (Advanced), by Mr. Pattison Muir, Caius College. Tuesdays, Thursdays, and Saturdays, at 10. Begin April 19.

Practical Chemistry, at the University Laboratory, daily. Begin April 12. Also at St. John's College. Begin April 16. Also at Caius College. Begin April 18. Also at Sidney College.

KING'S COLLEGE.

(Department of Engineering and Applied Science.)

Professor of Chemistry.—C. L. Bloxam, F.C.S.

Demonstrator of Practical Chemistry.—J. M. Thomson, F.C.S.

Assistant Demonstrator.—G. S. Johnson, F.C.S.

On Tuesday and Friday at 10.20 a.m. Students of the First Year are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a View of the Forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic elements and their principal Compounds are described.

The Metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts; and the processes of the different Manufactures, of Metallurgy, and of Domestic Economy, are explained and illustrated.

Examinations of the Class, both *vivâ voce* and by written papers, are held at interval during the course at the usual Lecture hour.

Second Year.—Students attend in the Laboratory twice a week, on Tuesday and Friday, at 10.20, and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this Department may be admitted to this Class at any period of his study on payment of an extra fee.

Experimental and Analytical Chemistry in the Laboratory.—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of extra Fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The laboratory hours are from ten till four daily, except Saturday, on which day the hours are from ten till one.

In addition to the Laboratory Fee, each Student defrays the expenses of his own Experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

Special hours and fees are arranged for the convenience of such Third Year Students as wish to study Analytical Chemistry.

Fees.—Chemistry per term, £3 3s. od.; per ann., £8 8s. od.; Practical Chemistry per term, £4 4s. od.; per ann., £10 10s. od.; Experimental and Analytical Chemistry—One Month (daily attendance), £4 4s. od.; Three Months (daily attendance), £10 10s. od.; Six Months (daily attendance), £18 18s. od.; Nine Months (daily attendance), £26 5s. od. A student taking a month's ticket may attend daily during 1 month, or 3 days a week during 2 months, or 2 days a week during 3 months.

Rules as to Admission of Students.

I. The Academical Year consists of Three terms: Michaelmas Term, from beginning of October to the week before Christmas; Lent Term, from the middle of January to the week before Easter; Easter Term, from Easter to the beginning of July.

II. The days fixed for the Admission of New Students in the Academical Year 1882-83, are Tuesday, October 3, Tuesday, January 9, and Wednesday, April 11.

METALLURGY.

Professor.—A. K. Huntington, F.I.C., F.C.S., &c.

The Laboratory for instruction in Metallurgy will be open to Students every day from 10 to 4 (except on Saturday, when the College closes at 1); on Friday evenings from 7 to 9.

Lectures will be delivered on Monday and Friday at 4 p.m. in the Michaelmas and Lent Terms; on Thursday at 3 p.m. in the Easter Term; and on Wednesday at p.m.

The following subjects are treated of in these Lectures: The Selection and Economic Preparation of Fuel and of Refractory Materials; the Methods by which Metals are obtained from their ores, and the means by which they are rendered suitable for the various requirements of the Arts.

Particular attention is made to the study of the Nature and Properties of Metals and Alloys available for Constructive Purposes.

In the Metallurgical Laboratory, which is always open during College hours, the relation between the Chemical Composition of Metals and their Mechanical Properties may be studied by the aid of Testing Machinery. The study of the other subjects above referred to, and also of Assaying, is carried on under the direction of the Professor.

Fees.—Lectures only, £3 3s. Practice (including Lectures), for one month, £6 6s.; two, £11 11s.; three, £15 15s.; six, £27 6s.; nine, £37 16s.

The Course of Evening Lectures will relate to Metals and Alloys, with special reference to the Manufacture of Brass and Bronze. Fees.—For Lectures only, £1 11s. 6d.; Laboratory only, £2 2s.

EVENING CLASSES.

Classes for Evening Instruction in various subjects are held during the months from October to March, inclusive, and during the months of April, May, and June. The next Winter Course will begin on Monday, October 9th, and will terminate on Friday, March 16th, 1883, the last fortnight being devoted to examinations. Many of these classes have special reference to the B.A. and Matriculation Examinations of the University of London.

Agriculture.—A Course of Lectures on this subject will be given during the ensuing Winter by Mr. Frederick James Lloyd, F.C.S., of the Royal Agricultural Society of England. The Lectures will be given on Thursday Evenings at 6 p.m., beginning October 12th, 1882. Fee, £1 11s. 6d. for the Course, to be paid in advance at the College Office.

UNIVERSITY COLLEGE.

FACULTY OF SCIENCE.

Chemistry.—Professor Williamson, Ph.D., F.R.S.

I. GENERAL COURSE.

Lectures daily (except Saturday) from 11 to 12 a.m., up to the last week in March.

Exercises on Tuesdays, Wednesdays, Thursdays, and Fridays, from 9 to 10 a.m. First Meeting, October 4, 1882

Fees for the Course, £7 7s.; Perpetual, £9 9s.; for the Half Course, £4 4s.; for the Organic Course alone, £2 2s.

Fee for the Exercise Class, £2 2s.

The instruction in this Class is of two kinds, consisting partly of Experimental Lectures by the Professor, partly of Exercises and personal instruction on the subject of the Lectures by an Assistant.

Attendance on the Exercise Class (conducted by Mr. Temple A. Orme, F.C.S.) enables Students to do their work more effectually and rapidly than they can do it by themselves.

A. *The first half* of the course, to Christmas, includes those parts of Chemistry which are required for the Matriculation Examination of the University of London.

B. *The second half* of the Course, from January to March, includes the following subjects:—

1. Preparation and properties of the chief *Metals*, including their characteristic reactions and most important salts. Detection of metallic poisons. Quantitative estimation of metals. Principles of classification. Monatomic, diatomic metals, &c.

2. *Organic Chemistry* commences in the second week in February, and occupies five Lectures weekly till about the end of March. It includes a study of the characteristics and metamorphoses of the chief organic acids, bases, alcohols, ethers, colouring-matters, &c. Methods of ultimate and proximate analysis. Determination of molecular weights. Theory of types; of compound radicals. Phenomena of fermentation, &c.

Training of Teachers.

Teachers of Chemistry are trained in the theory and practice of their profession. A two years' Course is absolutely requisite for this purpose; but Students will with advantage devote a longer period to it.

II.—ANALYTICAL AND PRACTICAL CHEMISTRY.

A. *Laboratory.*

When accompanied or preceded by attendance on the lectures on Chemistry, the Laboratory Course qualifies Students in the application of Chemistry to the Manufacturing Arts, Metallurgy, Medicine, or Agriculture, &c. Instruction is given in the principles and processes of gas-analysis.

The Laboratory and offices are open daily from 9 a.m. to 4 p.m., from October until the middle of July, with a short recess at Christmas and at Easter. Saturday, from 9 to 2.

Fees, for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

A Gold Medal and Certificates of Honour are competed for by students entered for the session.

B.—Summer Practical Courses.
Chemical Theatre.

1. *Elementary Course.* (*Men.*)—About Forty Lessons of one hour each, commencing in the first week of May.;

The first six weeks of the Course are occupied by the study of the chief non-metallic elements and their simple compounds. Metallic salts, &c., are subsequently studied.

Fees—including the cost of materials and apparatus: for the Course, £5 5s.; for a Second Course, £3 3s.

2. *Senior Course.* (*Men.*)—This Course consists of Twenty Lessons of two hours each, commencing in the first week in May.

The first half of the Course includes tests for fixed and volatile organic acids, nitrogenised acids, sugars, glycerin, alkaloids, &c.

The second half of the Course includes tests for mineral poisons in organic mixtures; also tests for organic bodies, such as alkaloids, when mixed with other organic substances.

Volumetric methods of the quantitative analysis of sugar and urea, chlorides, phosphates, hardness of water, alkalimetry, are practised.

Analysis of milk and ashes of blood.

Fees—including cost of materials and apparatus: for the Course, £5 5s.; for a Second Course, £3 3s.

III.—Summer Matriculation Course. (*Men.*)
Temple A. Orme, F.C.S.

This Course includes those parts of Chemistry which are required for the Matriculation Examination of the University of London.

The Course consists of about Twenty Lessons in Practical Chemistry, and of an equal number of oral lessons. These lessons will begin on April 10, 1883, at 11.

Fee, including cost of materials and apparatus, £4 4s.

IV.—Elementary Chemistry.
Chemical Theatre. (*Women*).

Lectures—Wednesday and Friday, from 4 to 5.

A Class of Elementary Chemistry, including the subjects required for Matriculation, will be given during the Winter Session, commencing Wednesday, October 11.

The instruction will consist partly of Lectures, partly of Laboratory Experiments performed by the Students.

Fees for the Course, including use of apparatus and materials, £4 4s.

Chemical Technology.
Professor Charles Graham, D.Sc., F.I.C.

Assistant.—C. J. Wilson, F.C.S.

The Course of instruction in this Department is designed to afford to Students who propose to devote themselves to industrial pursuits in which Chemistry plays an important part, or to prepare themselves for the profession of Consulting Chemist, the instruction essential for their success in their future line of work. It will also be found of great value in two of the branches (Organic and Inorganic Chemistry) in which the Degree of Doctor of Science can be taken at the University of London.

In the Session 1882-83, it is proposed to treat of the following subjects:—

(1) The Chemistry of the Alkali trade.
(2) Soap, Glass, Pottery, Cements.
(3) Chemistry of Brewing.
(4) Agricultural Chemistry.

Fees—for each Course, £2 2s.; for the four Courses together, £5 5s.

Laboratory of Chemical Technology.

The instruction in the Laboratory of Chemical Technology will consist of the examination and valuation of raw materials used, and of the final products obtained in various manufacturing industries, and of experimental examination of the processes employed in the arts and manufactures.

The Laboratories are open daily from 9 a.m. to 4 p.m., from the 4th of October until the middle of July, with a short recess at Christmas and at Easter. Saturday, from 9 to 2.

Fees—for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES.

Professor.—E. Frankland, Ph.D., D.C.L., F.R.S.
Assistant Professor.—F. R. Japp, M.A., Ph.D.
Demonstrators.—W. R. Hodgkinson, Ph.D., and P. F. Frankland, Ph.D., B.Sc.
Assistants.—G. S. Newth and H. Chapman Jones.

The Normal School of Science at South Kensington is intended, primarily, for the instruction of teachers, and of students of the industrial classes selected by competition in the examinations of the Science and Art Department. The Royal School of Mines is affiliated to the Normal School. Students entering for the Associateship of the School of Mines obtain their general scientific training in the Normal School. Other students are admitted so far as there may be accommodation for them, on the payment of fees fixed at a scale sufficiently high to prevent undue competition with institutions which do not receive State aid. The instruction in the Normal School is arranged in such a manner as to give the Students a thorough training in the general principles of Science, followed by advanced instruction in one or more special branches of Science. The Associateship is granted in certain divisions or lines of study. Students who go through any one of the prescribed courses of instruction and pass the necessary Examinations receive a Certificate of Associateship of the Normal School, or of the Royal School of Mines. But students who are not candidates for the Associateship are permitted to take up the course of instruction in one or more special branches of science, and on passing the examination receive a Certificate to that effect. The Associateship of the Normal School of Science is given in one or more of the following divisions:—Mechanics, Physics, Chemistry, Biology, Geology, and Agriculture, and the Associateship of the Royal School of Mines in Metallurgy and Mining.

The course of instruction is the same for all the divisions during the first two years, after which it is specialised in accordance with the Scheme detailed in the Prospectus of the School.

The Session is divided into two Terms. The first Term begins about the 1st of October and ends about the middle of February. The second Term begins in the middle of February and ends about the middle of June.

Examinations are held at the end of each course of instruction and at such other periods as may be found necessary. On the results of these examinations the successful candidates are arranged in two classes, first and second. There are also "Honours" examinations for the subjects of the third and fourth years, the successful candidates being placed in order of merit. A student obtains the Associateship who passes in all the subjects of the first two years and of the special division he select for his Associateship. A student who goes through the prescribed course of instruction in any subject and passes the final examination in it receives a certificate to that effect.

Students who do not wish to attend the lectures are admitted for short periods to the laboratories, at the discretion of the Professors. The fees for the Chemical, Metallurgical, and Physical laboratories are £5 per month; for the Biological and Geological laboratories £4 per month.

Admission is granted to persons desirous of attending certain courses of the lectures without the laboratory instruction, on payment of the lecture fees.

The fees which are shown in the following table must be paid to the Registrar of the School before the commencement of each course.

	Part I. Lecs.	Part I. Lab.	Part II. Lecs. & Lab.	Part III. Lecs. & Lab.	Part IV. Lecs. & Lab.
	£	£	£	£	£
Chemistry	5	16	18	18	
Physics	5	12	16	16	
Biology with Botany	4	8	8	4	8
Geology with Mineralogy ..	4	8	12		
Mechanics	4	6	10	10	
Metallurgy	2	16	18		
Assaying for Mining Students		12			
Mining	4	12			
Agriculture	4	10			
Astronomy	3				

Mathematics £3 per term. Practical Geometry and Mechanical Drawing £3 per term. Freehand Drawing £1 per term.

Thus the fees for the first two years amount to £75, and for the remainder of the course for the Associateship they vary from £30 to £40.

Both the private and the State-aided students are required to furnish themselves with certain instruments and apparatus before the commencement of the courses. These are enumerated in the syllabuses of the several subjects.

Officers of the Army, Navy, and Civil Service, recommended by their respective Departments, are admitted to the Lectures and Laboratories at half the foregoing charges.

Associates of the Normal School of Science and of the Royal School of Mines have the privilege of free admission to the Library and to all the courses of lectures.

Science teachers actually engaged in teaching who have passsed in the advanced stage, or in honours, in any subject in the May examination of the Science and Art Department, or in the December examination in Training Colleges, may attend any course of lectures on the payment of £1.

Several valuable Exhibitions, Scholarships, and Prizes are attached to the studentship.

Summer Courses for Teachers.—Short courses of instruction are given aunually, about July, in different branches of science for the benefit of teachers of science schools in the country. The courses last three weeks. About 200 teachers are admitted to them, and they receive 2nd class railway fare to and from London, and a bonus towards their incidental expenses of £2 each. (See Science Directory.)

Working Men's Lectures.—Three or four courses of evening lectures for working men are given annually during the winter months by the Professors and Lecturers of the Normal School and the School of Mines. The admission to each course of six lectures, which will be given at South Kensington, Jermyn Street, or Bethnal Green, is 6d. The number of tickets is limited by the size of the lecture theatre.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH.

Professor of Chemistry and Experimental Physics.—T. S. Humpidge, Ph.D., B.Sc. (Lond.)

The following courses of lectures will be delivered during the Session 1882-3, commencing on Sept. 18th.

1. *Inorganic Chemistry.*—A course of about 80 experimental lectures on the Non-Metals, Metals, and Theoretical Chemistry.

2. *Organic Chemistry.*—A similar course of about 40 lectures.

3. *Experimental Physics.*—A course of about 90 experimental lectures.

These lectures will all be delivered in the forenoon.

The *Chemical Laboratory*, fitted with appliances, will be open daily (Saturdays excepted), from 2 to 6 p.m.

Fee for all subjects extending over the whole Session, £10. Practical Chemistry, 5s. per term extra.

UNIVERSITY COLLEGE, BRISTOL.

Professor of Chemistry.—W. Ramsay, Ph.D.
Lecturer.—Sydney Young, B.Sc.

Day Lectures.

Inorganic Chemistry.

This Course treats of the principles of Chemistry, and of the Chemistry of the Non-Metals and Metals.

Lectures will be given at 9 o'clock on Mondays, Wednesdays, Fridays, and Saturdays during the First and Second Terms.

The lectures will be illustrated with experiments and diagrams.

Examinations will be held from time to time during the courses.

Fee, £4 4s. for two Terms, £3 3s. for one Term.

Special Laboratory Course.

Special instruction will be given on Tuesdays and Thursdays from 4 to 6. The Course is designed for Students entering for elementary examinations in Chemistry, and others to whom the hour may prove convenient.

Fees, £3 3s. for two Terms; £2 2s. for one Term.

Organic Chemistry.

This Course will relate to the more important groups of the Compounds of Carbon.

Lectures will be given during the Second Term on Tuesdays and Thursdays at 9 o'clock; during the Third Term on Tuesdays, Thursdays, and Saturdays at 9 o'clock.

Special Lectures will also be given.

Fee, £3 3s.

Advanced Course.

This Course will be given on Saturdays at 9 o'clock during the first and second Terms, and will be devoted to a more minute consideration of Chemical Theory, as shown in recent researches.

Fee, £2 2s.

Practical Chemistry.—Laboratory Instruction.

The Laboratory will be open daily from 10 a.m. to 5 p.m., except on Saturdays, when it will close at 1 p.m. Instruction will be given in the Laboratory in all branches of Practical Chemistry, including Qualitative and Quantitative Inorganic and Organic Analysis, the preparation of Chemical Products, and Inorganic and Organic Research. Special facilities will be afforded to those who desire to study Practical Chemistry as applied to the different processes employed in the Arts and Manufactures. The Laboratory is under the immediate supervision of the Professor and the Lecturer.

Fees in Guineas—

	Whole Day. 6 Days a Week.	Whole Day. 3 Days a Week.	Whole Day. 2 Days a Week.	Half Day. 6 Days a Week.	Half Day. 3 Days a Week.
Per Session	18	10	7½	12	7
,, Two Terms ..	13	7½	5½	8½	
,, One Term ..	7	4	3	4½	3
,, Month	3	2	1½		

In order that Students may have an opportunity of acquiring some knowledge of Applied Chemistry, excursions to some of the Mines and Manufactories of the neighbourhood will be occasionally made. They will be conducted by the Professor or by the Lecturer.

Evening Lectures.

Inorganic Chemistry.

Lecturer.—Sydney Young, B.Sc.

Wednesday and Friday, 8 to 9.

This course will consist of Two Lectures a week during the First and Second Terms; they will be devoted to the consideration of the Principles of Chemistry and Chemical Physics and the Chemistry of the Non-Metallic Elements. A few Lectures at the end of the Course will be devoted to the consideration of the Chemistry of Metals. Special attention will be paid throughout to

those products which have a practical application in the Arts and Manufactures.

Fee, 10s. 6d. for Two Terms; 7s. for One Term.

Technical Chemistry.—Special Courses.

Professor.—W. Ramsay, Ph.D.

First Term.—A Course of Lectures will be delivered on Thursday evenings at 8 o'clock, on Fuel, and on the Metallurgy of Iron and Steel.

Second Term.—A Course of Lectures will be delivered on Thursday evenings at 8 o'clock, on Wool, Silk, Cotton, Linen, and Jute. This course is designed to afford information to those engaged in the manufacture and sale of articles made of the above materials. It will imply no previous knowledge of chemistry; but those who purpose to attend it are recommended to enter the Evening Chemistry Classes during the first Term.

Fee, 10s. 6d. for two Terms; 7s. for one Term.

Chemical Scholarship.—Among others, a Chemical Scholarship of £25 is offered for competition.

All particulars may be learned by application to J. N. Langley, LL.D., Registrar and Secretary.

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

Chemical Department.

Professor.—Prof. E. Kinch, F.C.S., F.I.C.

Assistants.—H. H. Robinson, B.A., and Mr. W. James.

Systematic courses of Lectures are given on Inorganic, Organic, and Agricultural Chemistry, illustrated by experiments, and by the collections in the College Museum. They comprise, as preliminary, the laws of Chemical Combination and the general Chemistry of mineral bodies, and of the more frequently occurring bodies of organic origin, with the relationship of their leading groups; and, finally, the Chemistry of the atmosphere, of soils and manures, of vegetation and animal nutrition, and of Agricultural economy.

In the Laboratory practical instruction is given in the construction and use of apparatus and in Chemical manipulation and analysis, both qualitative and quantitative. After studying the simple operations and the properties of the commonly occurring substances, the Students are taught to analyse a series of compounds, and apply the knowledge thus obtained to the analysis of manures, soils, waters, foods and feeding stuffs, and ther substances met with in the ordinary course of Agricultural practice. Chemico-agricultural researches are undertaken by the senior Students under the direction of the Professor and his Assistants.

THE YORKSHIRE COLLEGE, LEEDS.

Professor of Chemistry.—T. E. Thorpe, Ph.D., F.R.S., F.C.S.

Assistant Lecturer.—C. H. Bothamley, F.C.S.

The Session begins October 3rd, 1882.

Students of the Leeds School of Medicine are admitted to any of the classes on payment of the class fees, and are not charged with the College entrance fee.

Lecture Courses.

1. General Course on Inorganic and Organic Chemistry—Monday, Tuesday, Thursday, and Friday, at 4 p.m., from October to the end of the second term. Fee for the Course, £4 4s.

2. Lectures on Laboratory Practice and Chemical Calculation—Wednesday, at 10 a.m., during the First and Second Terms. Fee, £1 1s.

3. Lectures on the Chemistry of the Non-Metals—Saturday, at 12, during the First and Second Terms. Fee, 10s. 6d.

Laboratory Courses.

The College Laboratory will be open daily from 9 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it will close at 1 p.m.

Fees for the Session.—Students working six days per week, £17 17s.; four, £13 13s.; three £11 11s.; two, £8 8s.; one, £4 4s.

Class in Practical Chemistry, Saturday mornings, from 9 to 12, during First and Second Terms. Fee £1 11s. 6d.

Practical Chemistry for Medical Students.—On Tuesday and Thursday, from 10 to 12 a.m., from May to July.

Evening Classes.

A Course of twenty Lectures by Mr. C. H. Bothamley, on the Elements of Inorganic Chemistry (the Non-Metals) will begin during the first and second Terms, on Wednesdays, at 8 p.m., beginning October 11. Fee, 10s. 6d.

A Course of Twenty Lectures by Mr. C. H. Bothamley on the Metals will be given during the first and second Terms, on Mondays, at 8 p.m., beginning Oct. 9. Fee, 10s. 6d.

Dyeing Department.

Instructor.—J. J. Hummel, F.C.S.

Lecture Course, with practical work in the Dye-house, for Students who wish to receive, on leaving the College, a certificate of proficiency in Dyeing; such certificate to be obtained by special examination in the several subjects of the Course, the latter extending over a period of two years.

Scholarships.

For Associates.—The Cavendish Scholarship. Value £50 per annum, tenable for one year.

Advanced Scholarships.—

The Brown Scholarship. Value £35, tenable for two years.

The Akroyd Scholarship. Value £30 per annum, tenable for two years.

Entrance Scholarships.—

The Salt Scholarship. Value £20 per annum, tenable for two years.

The Goodall Exhibition of £10, tenable for one year, will be awarded to the candidate who shall take the second place in the competition for the Salt Scholarship.

The Akroyd Scholarships. One, value £25, and one, value £20, tenable for two years.

The Brown Scholarships. One, value £25, and one, value £20, tenable for two years.

The Clothworkers' Company Scholarships. For Textile Department four Scholarships, and for Dyeing Department two Scholarships, each of the value of £25 per annum, and tenable for one year.

MASON SCIENCE COLLEGE, BIRMINGHAM.

Professor.—W. A. Tilden, D.Sc., Lond., F.R.S.

Assistant Lecturer.—W. W. J. Nicol, M.A. B.Sc., Edin.

Demonstrator.—G. H. Morris, Ph.D. F.C.S.

Elementary Course.

Twenty Elementary Lectures adapted to the requirements of beginners will be given in the Winter Term, and will be repeated after Christmas, on Mondays and Fridays at 12 o'clock. The Second Course will begin on the first Monday in March.

Persons entirely unacquainted with Chemistry are recommmended to attend these Lectures before entering for the General Course, which commences in October. Candidates for the Matriculation Examination of the University of London may obtain the instruction they require for that Examination by attending this Course.

General Course.

The General Course of Lectures on Chemistry will be found useful by Students who are afterwards to become Engineers, Architects, Builders, Brewers, or Manufacturers (such as Metallurgists, Alkali, Soap, Manure, Glass, or Cement Makers, Bleachers and Dyers, &c.)

Students preparing for the Intermediate Examination

in Science and Preliminary Scientific (M.B.) Examination of the University of London, should attend the Lectures on *Inorganic Chemistry* (Winter and Spring Terms).

Candidates for B.Sc. and Intermediate Examinations in Medicine will in general require only that part of the course (Summer Term) which relates to *Organic Chemistry*.

The full course, extending over three terms, will also satisfy the requirements of Students preparing for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

1. From October to March (Winter and Spring Terms). About one hundred lectures on *Inorganic and Elementary Organic Chemistry* will be given on Mondays, Tuesdays, Wednesdays, Thursdays, and Fridays, at 10 a.m., commencing Wednesday, October 4th, 1882. Fee, £3 3s. for a single term, or £5 5s. for the course from October to March.

2. April to June Summer Term. About forty lectures will be given on *Organic Chemistry*, or the chemistry of the most important series of carbon compounds. This course will include all the subjects required for the Intermediate Examination in Medicine of the University of London. Lecture Days.—Monday, Tuesday, Wednesday, and Thursday, at 10 a.m. Fee, £2 2s., or to those Students who have attended the first part of the general course, £1 1s.

In both these courses the instruction at least once a week will take the form of class teaching, and exercises will be set which students will be expected to work at home.

Laboratory Practice.

The College Laboratory will be open daily from 9.30 to 5, except on Saturdays, when it will be closed at 1 p.m.

Candidates for Intermediate Examination in Science, Preliminary Scientific (M.B.), B.Sc., and Intermediate Examination in Medicine of the University of London, may obtain in the Laboratory of the College the instruction necessary. The three months Course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health may be taken in the Mason College Laboratory.

The Ordinary Course for Medical Students is given on Tuesdays and Thursdays from 2 to 4 p.m. throughout the Summer Term.

Fees:—

	All day.	Three hours per day.
One Term	7 guineas	.. .. 4½ guineas.
Two Terms	13 „	.. .. 8½ „
Threee Terms	18 „	.. .. 12 „

A Course of short demonstrations and exercises will be given by the Professor or one of his Assistants once a week. All first-year Students will be required to attend, unless exempted for special reasons by the Professor. No Fee.

Metallurgy.—A Course of about twenty Lectures will be given in the Winter and Spring Terms (October to March), on Tuesday Afternoons at 2 o'clock, on the Principles and Practice of Metallurgy. Fee for the Course, £1 1s.

Arrangements will be made in the Chemical Laboratory or giving instruction in Practical Metallurgy.

Excursions.

During previous Sessions permission has been obtained to visit some of the great factories in or near Birmingham, in which chemical and metallurgical industries are carried on. Students have thus had most valuable opportunities of gaining a practical acquaintance with some branches of Applied Science. The privilege thus courteously granted by several manufacturers will, it is hoped, be enjoyed in every future Session. The excursions will be conducted by the Professor.

UNIVERSITY COLLEGE, LIVERPOOL.

Professor.—Campbell Brown, D.Sc.

The Session commences October 2nd. The Chemical Laboratories have been enlarged so as to accomodate 70 Lecture Students and 48 Working Students; further large extensions are in contemplation, and will probably be commenced very shortly.

Students desirous of having a thorough theoretical and practical acquaintance with Technical Chemistry, or who intend to adopt Chemistry as a profession, must devote at least three years to special study. They ought to have an ordinary school acquaintance with English Composition and Latin, and must be proficient in Arithmetic and the elements of Algebra.

They are recommended to adopt the following curriculum:—

First Year.—Chemistry—Course of Lectures on Theoretical Chemistry during the Autumn and Lent Terms; Chemical Laboratory, two or three days a week, during the Lent and Summer Terms; and the Practical Chemistry Class during the Summer Term. Mathematics, Pure and Applied, Physics or Geology, French or German.

Second Year.—Chemistry — Second Attendance on General Lecture Course, if necessary; Lectures on Organic Chemistry in the Summer Term. Chemical Laboratory, three days per week. Physics, Mathematics, German or French.

Third Year.—Any of the above-mentioned lectures which have not been attended. Chemical Laboratory, four or five days per week. Physical Laboratory, one day per week.

Special Certificates will be granted to those Students who pass through the above or a similar curriculum, and who perform their work and pass the periodical examinations to the satisfaction of the Professors; but these Certificates of Proficiency will only be given to such as can perform Practical Work in a reliable mannner. Remunerated appointments are occasionally offered to efficient Students of the third year.

The Laboratory is opened for Students from 10 a.m. to to 4.30 p.m. daily, on Saturdays from 10 to 1 only.

The Prospectus containing full particulars may be obtained of Adam Holden, 48, Church St., Liverpool, price 6d.

LIVERPOOL COLLEGE OF CHEMISTRY.

Lecturers.—George Tate, Ph.D., F.C.S., and Granville H. Sharpe, F.C.S.

The Session commences October 2nd, on and after which day the Laboratories will be open for practical instruction from 10 a.m. to 5 p.m.

Courses of Evening Lectures will also be delivered on Chemistry, Physics, Geology, Mineralogy, Agriculture, Metallurgy, Brewing, and the Alkali Manufacture.

For further particulars apply to the Principals.

UNIVERSITY OF DURHAM.
COLLEGE OF PHYSICAL SCIENCE, NEWCASTLE.

Professor of Chemistry.—P. Phillips Bedson, D.Sc., F.C.S.

Demonstrator—J. T. Dunn, B.Sc.

The Session will commence on October 2nd, 1882.

Junior Division.—General Principles of Chemistry. History of the Non-Metallic Elements. History of the Metals and their more important Native and Artificial Compounds. Principles of Qualitative Analysis. Elements of Organic Chemistry. Mondays, Wednesdays, and Fridays, at 12.5 p.m. *Senior Division.*—Organic Chemistry. Elements of Applied Chemistry, including Chemical Mineralogy and Analysis. Tuesdays and Thursdays, at 11. Fee, £5 5s.

Practical Chemistry.—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m. *Laboratory Fees.*—Students

working six days per week, £5 5s. per term; alternate days, £3 3s.; one day per week, £1 1s.

Courses of Study.—Students will be distinguished into Regular and Occasional. Regular Students will be required to follow such a course of study in the subjects professed in the College as will enable them to pass the Examinations for the title of Associate in Physical Science. Occasional Students will attend such classes as they may select. Every candidate for admission as a regular student must pass an examination on entrance, in reading, writing from dictation, English or Latin Grammar, arithmetic (including decimals), and geography. Registered students in medicine are exempted from this examination, or students who produce a certificate of having passed either of the two following examinations:—

1. Durham Senior Examination of Persons not Members of the University, held in June.

2. Durham Examination for Students in Arts in their first year, or any examination of a similar nature that may be accepted by the Council.

Associateship in Physical Science.—Every candidate for the Associateship in Physical Science, will be required to satisfy the examiners in three, at least, of the four subjects,—Mathematics, Physics, Chemistry, and Geology,—in an examination, to be held at the beginning of his second year.

The examination in Chemistry comprises:—General Principles of Chemistry. Elements of Inorganic Chemistry. Elements of Qualitative Analysis, including a Practical Examination.

The examination in Chemistry for Candidates at the end of their second year comprises:—Elements of Organic Chemistry and Applied Chemistry. Advanced Qualitative Analysis, including a Practical Examination. Elements of Quantitative Analysis.

Exhibitions.—Three Exhibitions of the value of £25, £15, and £10 respectively will be awarded in October next to Candidates desirous of attending the first year course of study in the College.

Candidates must send their names to the Secretary, on or before the 23rd of September, and specify, at the same time, the special subject in which they desire to be examined.

The examination will be held at the College, and will commence on Monday, the 2nd October.

Two Exhibitions of £15 each will be awarded at the next examination of "Persons not members of the University," which will be held at Durham, and elsewhere, in June next.

Scholarships.

T. Y. Hall Scholarship.—This Scholarship, of the yearly value of £20, tenable for three years by students attending two or more of the classes, will be awarded on the result of the first examination for the Associateship in Science.

Charles Mather Scholarship.—This Scholarship, of the yearly value of about £40, will be awarded on the result of the Final Examination for the Associateship in Science, and is tenable for one year from the time of obtaining the Associateship in Science, provided the Scholar continues his studies in the College to the satisfaction of the Professors.

Nathaniel Clark Scholarship.—This Scholarship, of the value of £15 for one year, will be awarded in October to that student who shall pass the First Examination for the Associateship in Science, and who shall be most distinguished in Chemistry and Geology. The Scholar will be required to attend the classes of Chemistry and Geology, so as to be qualified to take those subjects for the Final Examination for the Associateship in June next.

OWENS COLLEGE, MANCHESTER.

Professor and Director of the Chemical and Metallurgical Laboratories.—H. E. Roscoe, B.A., Ph.D., F.R.S., F.C.S.

Professor of Organic Chemistry.—C. Schorlemmer, F.R.S.

Demonstrators and Assistant Lecturers.—Mr. W. C. Williams, F.C.S., D.Sc., and Watson Smith, F.C.S.

The Session begins on October 3, 1882, and ends on June 22, 1883.

Technological Chemistry.

Persons desiring to attend this course will be required to enter the College under the ordinary conditions of studentship.

The object of this course is to offer to students intending to devote themselves more especially to Applied Chemistry as complete a training as the College can provide in those branches of instruction which form the scientific foundation of the subject.

The complete course of instruction extends over four years, and embraces the following subjects:—

First Year.—Chemistry Lectures, Junior and Tutorial classes. Chemical Laboratory, 2 days per week, and Analytical Chemistry Lectures class. Mathematical class, Section I. Experimental Mechanics. Geology (Stratigraphical). French or German. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Second Year.—Chemistry Lectures, Junior,* Senior, and Tutorial classes. Chemical Laboratory, 3 days per week. Technological Chemistry Lectures. Experimental Physics or Mineralogy Lectures. German or French. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Third Year.—Chemistry Lectures, Senior* and Tutorial classes. Organic Chemistry Lectures. Chemical Philosophy. Chemical Laboratory, 3 days per week. Technological Chemistry. Physical Laboratory, 1 day per week, or Practical Mineralogy and Technological Mineralogy. Mechanical Drawing, Practical (evening class).

Fourth Year.—Organic Chemistry Lectures.* Technological Chemistry. Chemical Laboratory, 4 days per week. Chemistry of Colouring-Matters, Dyeing, and Calico-Printing (4th evening course). Mechanical Drawing, Practical (evening class).

Fees.—First year (including College Admission and Library fees), £29 5s.; second year, £27 13s.; third year, £28 10s. 6d.; fourth year, £23 19s. 6d.

The aggregate of the fees in each year will vary slightly according to the particular class selected in French or German, or to the choice made in respect of the other alternatives proposed.

When a student is excused a second attendance on any of the Chemistry Lecture Courses the fee will be reduced accordingly.

Certificates will be granted to students on the successful completion of this course. Attendance on the full course of four years is expected of candidates for the Certificate, but students may obtain exemption (on cause shown) from the first or the first and second year's course. Students so excused will nevertheless be required to undergo examination in all the subjects specified.

The Certificate will state in which subjects the candidate has gained Honours, and in which he has merely satisfied the Examiners.

Entrance Exhibitions.

I. Victoria Exhibition (Classics), £15.

II. Wellington Exhibition (Greek Testament), £15.

III. Dalton Mathematical Exhibition, £15. Renewable for a second year.

IV. Grammar School Scholarship, £17 per annum, tenable for three years; open to scholars of the Manchester Grammar School only.

V. Two Oxford and Two Cambridge Local Exhibitions, giving free admission to lecture classes in the College for one year, and renewable for two years further, are awarded

* Students who gain a place in the First or Second class in the annual examinations will be excused a second attendance on these classes.

annually on the results of the Oxford and Cambridge Examinations held in Manchester in December, 1880, and June, 1881.

VI. Gilchrist Scholarship, £50 per annum, tenable for three years; awarded on the results of the Matriculation Examination of the University of London, in June, 1881.

VII. Rumney Scholarship, £45 per annum, tenable for three years.

VIII. Ramsbottom Scholarship, £40 per annum, tenable for two years. The next competition will take place in 1882.

IX. Crace-Calvert Scholarship, £25 per annum, tenable for two years. The next competition will take place in June, 1882. This scholarship is open only to duly qualified members of the Evening Chemistry Classes.

Fellowship.

The Langton Fellowship, £150 per annum, tenable for three years. Candidates must have been students in the College for not less than three sessions, and must during their studentship or within one year after the close of the same have obtained a degree of some University of the United Kingdom, or been elected to the Associateship of the College. The next competition for the Fellowship will take place in 1881.

Scholarships.

The following (except the Shakspere Scholarship) are open to the competition of students of the College only.

I. Victoria Scholarship (Classics), £40 per annum, tenable for two years.

II. Wellington Scholarship (Greek Testament), £20 per annum, tenable for two years.

III. Shuttleworth Scholarship (Political Economy), £50, tenable for one year.

IV. Shakspere Scholarship (English Language and Literature), £40 per annum, tenable for two years.

V. Bradford History Scholarship, £45 per annum, tenable for one year, and renewable for a second year.

VI. Dalton Chemical Scholarships, two, each of £50 per annum, tenable for two years.

VII. Dalton Mathematical Scholarships, one Senior and one Junior Scholarship, of the value of £25 each, tenable for one year.

VIII. Platt Scholarships (Physiology), two, one offered annually, £50 per annum, tenable for two years. (Two Platt Physiological Exhibitions of £20 each are offered for competition at the end of the Session 1880-1, open to first and second years' students in Physiology.)

IX. Heginbottom Physical Scholarship, £30 per annum, tenable for two years.

X. Ashbury Scholarships (Engineering), two, each of £25 per annum, tenable for two years.

Prizes.

I. Lee Greek Testament Prizes, one of £25 and one of £12 10s. value.

II. Classical Prizes.—Essay, value £5. Junior Class Prizes, value £5 and £2 10s.

III. Shuttleworth History Prize, value £5.

IV. English Essay and Poem Prizes, each of the value of £5.

V. Early English Text Society's Prizes.—A selection of the Society's publications offered to the competition of students in the Day and in the Evening Classes respectively.

VI. New Shakspere Society's Book Prizes.

VII. Cobden Club Book Prizes (Political Economy).

VIII. Dalton Natural History Prize, value £15.

IX. Engineering Essay Prize, value £5.

UNIVERSITY COLLEGE, NOTTINGHAM.

Professor of Chemistry—Frank Clowes, D.Sc. Lond., F.I.C., F.C.S.

Demonstrator—Mr. J. B. Coleman.

Lecture Courses.—A systematic course of morning lectures is delivered on Tuesday and Thursday mornings at 10 o'clock: the non-metals are treated of in the Autumn Term (2nd October to 16th December), the metals in the Spring Term (15th January to 31st March), and the carbon compounds in the Summer Term (23rd April to 7th July).

A course of evening lectures runs parallel with the morning course, being delivered on Wednesday evenings at 8 o'clock.

A tutorial class in connection with both courses meets on Wednesday evenings at 7 o'clock.

Students may qualify themselves by attendance at these lectures and classes for the Examinations of the London University, or for the Cambridge or Oxford University Extension Examinations: they may also obtain instruction in Chemistry for technical or other purposes.

Fees.—For morning lectures, one guinea per term; for evening lectures, 2s. 6d. per term; or 5s. for lectures and classes.

Practical Chemistry.—The chemical laboratory is open on Monday, Wednesday, and Friday mornings from 10 to 1, on Thursday afternoons from 3 to 6, on Tuesday evenings from 6.30 to 9.30, and at other times by arrangement. Each Student works independently of other Students at a course recommended by the Professor. Instruction is given in Chemical Analysis, and in Experimental and Applied Chemistry. A set of ordinary apparatus and reagents and a private locker are supplied free of charge, for the safe keeping of which the Student is held responsible; no extra charge is made for the use of gas and water, and of the cheaper chemicals.

Fees.—For Day Students, one guinea per term for each three hours weekly; for Evening Students, half-a-guinea per term.

Pharmaceutical Chemistry.—A course of lectures suited to Students for the Minor Examination of the Pharmaceutical Society is delivered throughout the Session at 8 on Monday evenings. Pharmaceutical Students are also admitted to the Chemical Laboratory at any time by arrangement with the Professor.

Fees.—For lectures, 3s. 6d. per term; for laboratory work, half-a-guinea per term for each three hours weekly.

Students in the Government Classes work under the direction of the demonstrator on Monday, Tuesday, and Thursday evenings.

All classes of Students are eligible to attend without distinction of sex. For other information Students are referred to the College Calendar.

FIRTH COLLEGE, SHEFFIELD.

Professor of Chemistry and Experimental Physics.—T Carnelley, D.Sc.

The Session will commence on Tuesday, October 3, 1882.

First Year's Course.—Chemistry of the Non-Metallic Elements. Tuesday, Thursday, Saturday, from 9 to 10 a.m. Fee, £3 13s. 6d.

Second Year's Course.—Chemistry of Metals: Organic Chemistry. Monday, Wednesday, Friday, from 9 to 10 a.m. Fee, £3 13s. 6d.

Laboratory.—Working hours to be arranged between Professor and Students.

Sessional Fees for Day and Evening Students:—Four hours per week, £3 4s.; Six, £4 8s.; Eight, £5 12s.; Ten, £6 16s.; Twelve, £8; Fifteen, £9 14s.; Eighteen, £11 4s.; Twenty-four, £14; Thirty, £16 16s.; Thirty-six, £19 2s.; Forty-two, £21.

Day Students may not enter for less than six hours a week.

Students joining the Laboratory at or after Christmas will be charged two-thirds, and at or after Easter one-third of the Fees for the whole Session.

Fees for short periods:—For one month, £3 13s. 6d.; two months, £6 6s.; three, £9 9s.; four, £12 1s. 6d.; five, £14 3s. 6d.

Evening Classes.—Lecture, Tuesday, 7 to 8; Class, 8 to 9. Fee, 5s. per term, or 9s. per two terms. Laboratory instruction, Wednesday, 7 to 9. Sessional Fee, £2 2s.

(Students joining the laboratory at Christmas will be charged half the fee for the whole Session).

UNIVERSITY OF EDINBURGH.

Professor.—A. Crum Brown, F.R.S.E.

The Session will commence on October 25, 1882.

Two degrees in Science are conferred by the University of Edinburgh, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.). Both these degrees are conferred in Physical and Natural Science, in Public Health, and in Engineering.

Candidates for degrees in Physical and Natural Science must pass a preliminary examination in English, Latin, Arithmetic, the Elements of Mathematics, and the Elements of Mechanics, and in at least two of the following subjects:—Greek, French, German, Higher Mathematics, Natural Philosophy, Logic, and Moral Philosophy.

The First B.Sc. Examination embraces Mathematics, Natural Philosophy, Chemistry, Zoology, including Comparative Anatomy, and Botany. The Second B.Sc. Examination the Higher Higher Mathematics, Natural Philosophy, Experimental Physics, Chemistry, Zoology, Botany, Physiology, and Geology.

The D.Sc. Examination embraces Mathematics, Applied Mathematics, Experimental Physics, Practical Astronomy, Chemistry, Zoology and Comparative Anatomy, Animal Physiology, Botany, and Geology, including Palæontology and Mineralogy.

ANDERSON'S COLLEGE, GLASGOW.

Professor of Chemistry.—William Dittmar, F.R.S.E.

Chief Assistant.—John M'Arthur.

Laboratory Assistant.—James B. M'Arthur.

Class Tutor.—Joseph Sayers.

Junior Assistants.—Thomas Barbour, Robert Anderson, Archibald Kling.

A Course of 100 Experimental Lectures on Chemistry: Daily, Saturdays excepted, from 10 to 11, commencing on Wednesday, Nov. 1st. The Lectures up to the end of the year are devoted to the elements of Chemical Philosophy and to the Chemistry of the Non-metallic Elements. After the new year the Course divides into two branches, viz., the Chemistry of the Metals (on the Mondays and Tuesdays) and Organic Chemistry, select chapters (on the Wednesdays, Thursdays, and Fridays). Six written examinations are held during the Session, which all the members of the class are required to attend.

Fee, £2 2s.

The Laboratory for Practical Instruction in all branches of analysis, including technical assaying, and for original research is open daily (Saturdays excepted) during the Winter Session from 10 to 5, during Summer from 9.30 to 5. Advanced students may obtain permission to work privately on Saturday also until 11 p.m. The teaching is conducted on the tutorial system, each student working by himself and on his own subject. The Laboratory is furnished with all the necessaries for chemical investigation.

Fee for the Winter Session, £10 10s.; Summer Session, £6 6s.; two sessions, if paid in advance, £15 15s., or £2 2s. per month.

A Special Practical Class for Medical Students, meeting twice a week during the Summer Session.

Evening Lectures, commencing on Friday, Sept. 29th, at 8 p.m.

THE "YOUNG" CHAIR OF TECHNICAL CHEMISTRY, ANDERSON'S COLLEGE.

Professor.—Edmund J. Mills, D.Sc. (Lond.), F.R.S.

Senior Assistant.—Mr. J. Snodgrass.

Junior Assistant.—Mr. B. Hunt.

This Chair has for its object the instruction of Students in Chemistry as applied to the various branches of industry in Chemical and other works, Metallurgy, Agriculture, &c.

LECTURES.—*Principal Course.*—A Course of Twenty-five Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m., commencing on November 6th. The Lectures will be illustrated with Experiments, Diagrams, and Models, as well as by the actual Inspection of Manufacturing Processes; and the progress of the Students will be tested by periodical Examinations. These Lectures will have reference to units of weight and measure, to the calculations necessitated by Chemical operations, and to the nature and laws both of the Chemical process and its results, as illustrated in Chemical Technology.

Fee for the Course, One Guinea.

Subsidiary Course.—A subsequent Course of Thirty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m. These Lectures are more particularly intended for Dyers, Colour Manufacturers, Brewers and Distillers, Tar Rectifiers, Drysalters, and others interested in a knowledge of Technical *Organic* Chemistry.

Fee for the Course, Two Guineas.

Special Subject.—The Professor will deliver a Course of Twenty-five Lectures on Bleaching, Dyeing, and Printing. The Course will commence about the middle of October; and the Lectures will be delivered on Monday evenings, at 8 p.m. These lectures will qualify for the examinations of the City and Guilds of London Institute.

Fee, One Guinea.

Iron and Steel Manufacture.—Mr. J. Snodgrass, F.C.S., Registered Teacher in the City and Guilds of London Institute, will deliver a Course of Evening Lectures on the above Subject, in time for the May Examination. Further particulars will be subsequently announced.

Laboratories.—The Laboratories are open daily from 10 to 4, and on Saturday from 10 to 1 o'clock for practical working by the Students, under the superintendence of the Professor and his Assistants.

The Fee for attending the Laboratories is £20 per Session of Nine Months, £14 10s. for Six Months, £7 10s. for Three Months, or £2 10s. per month.

Students must have a fair acquaintance with elementary Chemistry.

The New Laboratory Buildings, immediately contiguous to the former site, are now erected and occupied. They comprise four stories, with a lecture room in the rear, and are exclusively devoted to the purposes of this Chair.

The Trustees, having had under consideration the requirements of Inventors, Patentees, and others whose investigations require isolation and privacy, as well as professional advice, have included in the arrangements Five Private Laboratories for Technical Research.

Library.—A Students' Library Society was founded in 1875. Its objects are to provide a collection of standard chemical works, and to maintain a regular supply of chemical journals. A large number of works have already been purchased or bestowed, and nine journals are received. Annual subscription, Half-a-crown.

Memorandum as to Bursaries.

The Trustees of the "Young" Chair have the superintendence of the Bursaries—regulating the appointment and terms on which they shall continue to be held.

The Nominees of Donors to be appointed if they pass the necessary examinations.

The Bursaries are of the amount of £50 each per annum, tenable for three years, during which the Bursars shall be required to give their whole time and attention to the Lectures and Laboratory duties of the "Young" Chair, paying the ordinary fees. Candidates to have attained sixteen years of age on application, to be of good moral character, and to pass such examinations as may be prescribed by the Trustees in the ordinary branches of an English education and the elementary principles of Chemistry. The Bursaries to be liable to forfeiture on the Bursars failing to exhibit approved progress under the Professor of the Chair, or being guilty of conduct, in the

opinion of the Trustees, unworthy of their position. The Bursaries are only given to those whose means are limited, and who intend following some branch of Manufacturing Chemistry.

QUEEN'S COLLEGE, BELFAST.

Professor.—E. A. Letts, Ph.D., F.R.S.E., F.C.S.

The Session begins October 17th.

I.—*Chemistry.*—The lectures are delivered at 3 p.m., on the first five days of each week during the College Session. The course is divided into three parts:—(1) Chemical Philosophy; (2) Inorganic Chemistry; (3) Organic Chemistry. In addition to the ordinary lectures, there will be additional ones—partly on Elementary, and partly on advanced Chemistry.

II.—*Practical Chemistry.*—In this course the Students are instructed in the general methods of conducting Chemical Analyses.

III.—*Laboratory Pupils.*—The Chemical Laboratory is open during the College Session on the first five days of the week, from 10 a.m. until 3 p.m. The course of instruction is under the direction of the Professor of Chemistry, and of the Chemical Assistant. Students are admitted as working pupils on payment of a fee of £10 for the College Session, or of £3 10s, for one term.

QUEEN'S COLLEGE, CORK.

Professor.—Maxwell Simpson, D.Sc., M.D., F.R.S., &c.

The Session begins October 17th. The Chemistry Classes are held on Mondays, Wednesdays, and Fridays.

The Course is divided into Inorganic and Organic Chemistry.

In the first part are discussed the Laws of Combination and Affinity, Molecular Chemistry and Crystallography, and the History of the Non-Metallic and Metallic substances.

In the Organic portion of the Course will be considered the subjects of Organic Analysis, Organic Series, Compound Radicals and Types, Metamorphosis of Organic Bodies, History of Special Animal and Vegetable Bodies.

In treating of the Laws of Chemistry, and the History of Inorganic and Organic Bodies those points will be chiefly dwelt upon which have a practical bearing in the Arts, Medicine, Engineering, and Agriculture. Thence, during the Course, attention will be directed to the application of Chemistry to Medicine and Physiology, to Metallurgic Operations, Chemical Manufactures, Building Materials, Soils, and Manures.

Fee.—For each Sessional Course, £2. Each subsequent Course in Medicine, £1.

The Chemical Laboratory is open daily except on Saturdays, from 10 to 4 o'clock, under the Superintendence of the Professor, to Students desirous of prosecuting an extended course of qualitative and quantitative analysis, and for the purpose of original investigation in connection with the Arts, or in the higher departments of Scientific Chemistry.

ROYAL COLLEGE OF SCIENCE FOR IRELAND, Stephen's Green, Dublin.

Professor of Practical and Theoretical Chemistry.—W. Noel Hartley, F.C.S.

The Session commences on Monday, October 2, 1882.

The Chemical and Metallurgical Laboratories, under the direction of Mr. Hartley, are open every week-day during the Session, except Saturday. Instruction is given in the different branches of Analytical Chemistry, including Assaying, and in the methods for performing Chemical Research. Fee, for the Session of nine months, £12; or for three months, £5; or for one month, £2.

There are four Royal Scholarships of the value of £50 each yearly, with Free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are given to Students who have been a year in the College. There are also nine Exhibitions attached to the College, of the yearly value of £50 each with Free Education, including Laboratory Instruction, tenable for three years; three become vacant each year.

A Diploma of Associate of the College is granted at the end of the three years' course.

Evening Classes.—Systematic Courses of Evening Lectures are given by most of the Professors throughout the Session.

CHEMICAL LECTURES, CLASSES, AND LABORATORY INSTRUCTION.

City and Guilds of London Institute for the Advancement of Technical Education, Cowper Street, Finsbury.—Session commences October 3, 1882. Day and Evening Lectures and Laboratory instruction.

City of London College, 52, Leadenhall Street, E.C.—Chemical Lecturer—Dr. A. C. Maybury. The courses of lectures are as follows:—

Elementary Electricity	Mondays,	6.30—7.30.
Elementary Chemistry	,,	7.30—8.30.

The Session will commence on Monday, October 2. Fee, 6s. per term; per session, 15s.

These classes are specially arranged for Students preparing for the Science and Art Department Examinations, Matriculation, Chemists' Assistants, Teachers, &c.

Crystal Palace Company's School of Art, Science, and Literature. School of Practical Engineering. *Principal*—Mr. J. W. Wilson, Assoc. Inst. C.E.—This school was established with the purpose of affording to Students of Civil or of Mechanical Engineering the advantage of thorough practical instruction in the rudiments of either profession, and in the manipulation of materials. The leading object is to prepare Students, by systematic practical instruction, for professional articles, so that on entering an Engineer's office or works the pupil may at once be useful to his Principal, and enabled to take advantage of the opportunities for learning open to him, because he has mastered the elementary details of the profession. The school is also available for Students already articled, who desire instruction in either the offices or shops. The Colonial Section is designed particularly for gentlemen who are going to the Colonies or abroad, as explorers or settlers. The object proposed is to afford them so much practical knowledge of scientific and mechanical work and expedients as shall enable them best to utilise the means at their disposal, especially when entirely dependent on their own resources.

Ladies' Division.—The School was established to utilise the valuable Courts and Collections of the Crystal Palace for the purposes of instruction in Art, Science, &c., so that education of the highest class might be afforded on reasonable terms under most advantageous conditions. The system of tuition is, for some subjects, in the manner of private tutorial instruction by the best masters, but other subjects are taught on the University method, in accordance with the regulations laid down by the Syndicate of the University of Cambridge, by whom some of the lectures and classes are conducted. A student may take lessons in one or several studies at option. The School is a centre for both the University of Oxford and the University of Cambridge Local Examinations, the Oxford Examination for Women, and for the Cambridge Higher Local Examination. The following examinations will be holden in the Ladies' Division during 1882-83:—Cambridge Local, December, 1882; Oxford Local and Oxford Examination for Women, June, 1883; Cambridge Higher Examination, June, 1883. The session opens on October 1.

Charterhouse Institution.—The Session commenced September 16, under the presidency of the Rev. Henry Swann, M.A, Lectures and Practical Work in a well-fitted laboratory capable of holding 60 students.

CHEMICAL LECTURES AT LONDON HOSPITALS.

Chemical Schools and Colleges.	Winter Session.				Summer Session.			
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			One Course.	Perpetual.			One Course.	Perpetual.
			£ s.	£ s.			£ s.	£ s.
St. Bartholomew's Hosp. and College	Dr. Russell, F.R.S.	M. W. F., 9	6 16/6	9 9	Dr. Russell	M. Tu. F., [to 1 11	3 3	3 3
Charing Cross Hospital and College	Mr. Heaton	M. W. F., 4	5 5		Mr. Heaton	M. Th., 3·5	4 4	
St. George's Hospital ..	Mr. Donkin	Tu. Th. S., 11½	7 7	8 18	Mr. Donkin	Daily at 10	4 4	
Guy's Hospital	Dr. Debus, F.R.S., and Dr. Stevenson	Tu. Th. S., 11	7 7		Dr. Debus	M. W. F., 10 to 1	7 7	
King's College and Hosp.	Mr. Bloxam, F.C.S., Mr. Thomson, and Mr. Johnson	M. W. Th., 10¼	8 8	11 11	Mr. Bloxam and Mr. Thomson & Mr. Johnson	M. W. Th., 10¼	6 6	8 8
London Hospital	Dr. Tidy	M. W. F., 10.30	7 7	10 10	Dr. Tidy	M. Th. S., 9	5 5	
St. Mary's Hospital ..	Dr. Wright	M. Th. 10, W. S., 9	6 16/6		Dr. Wright	W. F. S.	4 4	
Middlesex Hospital ..	Mr. W. Foster	M W. Th. Fr., 3	6 6	8 8	Mr. W. Foster	M. W. F., 3	4 4	
St. Thomas's Hosp. & Schl.	Dr. Bernays	Tu. Th, F., 10½	7 7	10 10	Dr. Bernays	M. Th. F., 10	6 6	
University Col. & Hosp.	Dr. Williamson, F.R.S.	Daily (ex. S.), 11	7 7	9 9	Dr. Williamson	Dy. (ex. M. S.) 11	5 5	
Westminster Hospital ..	Dr. Dupré, F.R.S., and Mr. O. Hehner, F.C.S.	W. Th. F., 3	6 6	8 8	Dr. A. Dupré and Mr. O. Hehner	M. W. F., 10	4 4	

Birkbeck Literary and Scientific Institution, Southampton Buildings, Chancery Lane. — Inorganic Chemistry. Lectures:—Elementary, Tuesdays, 8.30 to 9.30; Advanced, Saturdays, 7 to 8. Practice:—Elementary, Saturdays, 4 to 6; Advanced, Saturdays, 8 to 10. Teacher, Geo. Chaloner, F.C.S. Organic Chemistry:—Course of Thirty Lectures will be given on Tuesday evenings, at 7 o'clock, by Mr. H. Chapman Jones, F.C.S., commencing on October 3rd. Practical Organic Chemistry:—This Class will meet in the Laboratory of the Institution, under Mr. Chapman Jones's direction, on Saturdays from 4 to 6 and from 8 to 10 p.m.

Berners College of Chemistry and the Experimental Sciences, 44, Berners Street, W.—Prof. E. V. Gardner, F.A.S., M.S.A. The Laboratory is open morning and evening throughout the year. A practical School of Science of a private character; the Courses of study are carried on by private class lectures in the various subjects, and by private Courses of study. These Courses are limited as to time, but are continued so long as is necessary to the Complete practical study of the subject or subjects by the Pupil or Pupils. The studies embrace the Experimental Sciences and Chemistry—Agricultural, Technical, and Analytical; the Science and Practice of Photography, Steam, Telegraphy, Electricity, Magnetism, and Galvanism, the Natural Sciences of Mineralogy, Geology, and Botany. The preparation of Gentlemen for the various Examining Boards and investigations connected with Patents are prominent features of the work of this College.

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Onslow College of Science, 183, Kings Road, Chelsea, S.W.—Special Evening Classes in Inorganic and Organic Chemistry, &c. The Chemical and Physical Laboratory is open every evening for practical work from 7 to 10 p.m. Principal, Mr. W. H. Martin.

School of Pharmacy of the Pharmaceutical Society of Great Britain, 17, Bloomsbury Square.—The school opens on Monday, the 2nd of October. Lectures on Chemistry and Pharmacy, by Professor Redwood, on Monday, Tuesday, and Wednesday mornings, at 9 a.m. The Laboratories for Practical Instruction in Chemistry as applied to Pharmacy, &c., under the direction of Prof. Attfield, will be open daily at 10 a.m. throughout the Session. They are fitted up with every convenience for the study of the principles of Chemistry by personal experiment. They are specially designed for the student of Pharmacy, but are equally well adapted for the acquirements of a knowledge of Chemistry in its application to Medicine, Manufactures, Analysis, or Original Research. There is no general class for simultaneous instruction, each student following an independent course of study always determined by his previous knowledge; pupils can therefore enter for any period at any date. Fees, One Course, £3 3s.; an entire Session—Two Courses, £4 4s.; Perpetual Admission, £5 5s. *Council Prizes.*—At the end of each of the five months' Courses of Lectures on Chemistry and Pharmacy, and Botany and Materia Medica, a Bronze Medal and Certificates of Merit, and at the close of the Session (ten months) a Silver Medal and Certificates of Honour and Merit, are offered for competition by the Council. In the Class of Practical Chemistry, a Silver Medal, two Bronze Medals, and Certificates of Honour and Merit, offered by the Council, are competed for at the end of the Session only.

South London School of Chemistry, 325, Kennington Road.—Dr. John Muter, F.C.S. Daily, at 10 a.m. Sixty Lectures on Theoretical Chemistry, and Junior and Senior Course of Practical Chemistry.

St. John's Training College, Battersea.—Both Theoretical and Practical Chemistry form part of the curriculum of the College. Lecturer, Alfred Senier, M.D., F.I.C., F.C.S.

The Westminster College of Chemistry and Pharmacy, Trinity Square, S.E.—Messrs. Wills and Wootton. Daily, at 10 a.m. Theoretical and Practical Chemistry. Also Evening Classes, at 7.

Birmingham.—Queen's College.—In connection with this College the Chemistry Lectures are given at Mason Science College, by Prof. W. A. Tilden.

Bristol Medical School.—Mr. T. Coomber, F.C.S.

Liverpool Royal Infirmary School of Medicine.—J. Campbell Brown, D.Sc. Lond., F.C.S.

Institute of Technical Chemistry, Philadelphia Chambers and Ashton Chambers, Hackin's Hey, Liverpool.—Mr. A. Norman Tate. The laboratories have lately been entirely re-arranged and considerably extended, and are provided with all appliances necessary for analytical investigations, special technical examinations, and students' work.

LEEDS SCHOOL OF MEDICINE.—Prof. T. E. Thorpe, Ph.D., F.R.S.

LEEDS MECHANICS' INSTITUTION.—Mr. G. Ward, F.C.S. Evening Classes.

QUEENWOOD COLLEGE, near Stockbridge, Hants.—Dr. H. Wilson Hake, F.C.S., F.I.C. Lectures on Inorganic Chemistry and Physics and Laboratory Instruction. Principal, Mr. C. Willmore.

SALFORD WORKING MEN'S COLLEGE, EVENING CLASSES.—Teacher of Chemistry, Mr. G. H. Hurst. Lectures on Organic and Inorganic Chemistry and practical laboratory instruction.

SHEFFIELD SCHOOL OF MEDICINE.—Mr. A. H. Allen, F.C.S. A course of Fifty-six Lectures on Inorganic and Organic Chemistry is delivered by Mr. Alfred H. Allen. The Summer Course of Practical Chemistry is under the direction of Mr. A. H. Allen.

SHEFFIELD BOROUGH ANALYSTS' LABORATORY, 1, Surrey Street.—Mr. A. H. Allen, F.C.S. Day and Evening Classes.

WESLEY COLLEGE, SHEFFIELD.—Lectures on Chemistry and Physics, by Mr. A. H. Allen, F.C.S., and on Natural Philosophy, and Natural Science by the Rev. W. H. Dallinger, F.R.S.

UNIVERSITY OF ABERDEEN.—Mr. J. S. Brazier, F.C.S.

DUNDEE LITERARY INSTITUTION CHEMICAL AND PHYSICAL LABORATORY.—Lecturers on Chemistry, Mr. Frank W. Young, F.C.S., and Mr. John Thomson. Classes and Evening Lectures daily.

SCHOOL OF MEDICINE, SURGEON'S HALL, EDINBURGH.—Dr. Stevenson Macadam, F.R.S.E., Mr. Falconer King, Mr. Ivison Macadam, Mr. Drinkwater, and Mr. Buchanan.

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MINTO HOUSE MEDICAL SCHOOL, CHAMBERS STREET, EDINBURGH.—Mr. J. Falconer King, F.I.C., F.C.S. Lectures and Classes.

NEW VETERINARY COLLEGE, GAYFIELD HOUSE, EDINBURGH.—Dr. Stevenson Macadam and Mr. Falconer King, F.C.S.

GLASGOW UNIVERSITY.—Prof. J. Ferguson.

GLASGOW VETERINARY COLLEGE.—Professor Cooke, F.C.S.

COLLEGE of SCIENCE AND ARTS, GLASGOW.—Mr. R. R. Tatlock, F.C.S., and Dr. Clark, F.C.S. Day and Evening Classes.

SCHOOL OF CHEMISTRY, 138, Bath Street, Glasgow.—Dr. Wallace, Mr. Tatlock, and Dr. Clark. Day and Evening Classes.

CHEMICAL LABORATORY, 180, West Regent Street, Glasgow.—Dr. Milne. Day and Evening Classes.

UNIVERSITY OF DUBLIN, Trinity College.—Dr. Emerson Reynolds, F.R.S.

QUEEN'S COLLEGE, GALWAY.—Dr. T. H. Rowney.

MUNSTER AGRICULTURAL AND DAIRY SCHOOL.—Thomas Farrington, M.A., F.C.S.

ROYAL COLLEGE OF SURGEONS IN IRELAND.—Dr. C. A. Cameron, F.I.C. The Laboratories of the College are provided with every appliance for the study of Chemistry, especially in its application to Medicine, Hygiene, and Pharmacy.

DUBLIN, CARMICHAEL COLLEGE OF MEDICINE.—Dr. C. R. C. Tichborne.

DUBLIN, CATHOLIC UNIVERSITY.—Mr. Campbell.

DUBLIN, DR. STEEVENS'S HOSPITAL AND MEDICAL COLLEGE.—Mr. McHugh.

MECHANICS' INSTITUTE, Abbey Street, Dublin.—Mr. Clement J. Leaper.

UNIVERSITY COLLEGE, LIVERPOOL.

The SESSION will commence on Monday, October 2nd. EVENING CLASSES on October 9th.

Full Courses of Lectures for all London University Examinations in Arts or Science. Physical, Chemical, and Biological Laboratories.

All Classes (except the Medical) open to both sexes on the same terms.

For full details of Classes, Fees, &c., see "Calendar" (price 2s.), published by ADAM HOLDEN, 48, Church Street, Liverpool.

FIRTH COLLEGE, SHEFFIELD.

SESSION 1882-83.

The Session will commence on Tuesday, OCTOBER 3rd. Prospectuses may be obtained on application. The Chemical Laboratory is fitted up with accommodation for instruction in the higher branches of Chemistry, and for research.

The Examination for Entrance Exhibitions (two of £15 each) will be held on SEPTEMBER 28th and 29th. Candidates must not be over 21 years of age. Notice of their intention to compete must be sent to the Registrar not later than September 26th. For further particulars apply to

ENSOR DRURY, Registrar.

EDINBURGH SCHOOL OF MEDICINE,

MARSHALL STREET, NICOLSON SQUARE.

The CHEMISTRY CLASSES conducted by Dr. DRINKWATER will be resumed on Tuesday, October 24th. The Lectures will be delivered daily at 10 a.m. The Laboratories are open from 9 a.m. to 5 p.m. Special Classes for Sanitary Chemistry.

Now Ready, No. CV., for SEPTEMBER, Price 1s. 6d.

THE JOURNAL OF SCIENCE.

CONTENTS.

1. Witchcraft, Insanity, and Crime. By Frank Fernseed.
2. Bestiarianism *v.* Common Sense.
3. Jottings on Odours, and their Recognition. By J. W. Slater.
4. Agricultural Possibilities. By An Old Technologist.
5. Will-o'-the-Wisp again. By W. Mattieu Williams.
6. Experimentation in Biology. By Oswald Dawson.

Analyses of Books. Correspondence. Notes.

London: 3, Horse-Shoe Court, Ludgate Hill.

METROPOLITAN BOARD OF WORKS.

APPOINTMENT OF GAS EXAMINERS.

THE METROPOLITAN BOARD OF WORKS is about to appoint two Gas Examiners, whose duty it will be to test daily the lighting power, purity, and pressure of the gas supplied in certain districts of the Metropolis, at the testing-places fixed by the Gas Referees. One of the testing-places for which an Examiner is now required is in Wellclose Square, and the other in Graham Road, Dalston. Testings of illuminating power are required to be made three times at least each day, at intervals of not less than one hour, and the hours of testing are fixed from time to time by the Board. The mode of testing the lighting power, purity, and pressure is prescribed by the Gas Referees. The persons to be appointed must have had previous experience such as to qualify them for the work, and this experience must be stated in the letter of application, which should be accompanied by testimonials as to character and competence, and should also state the age of the candidate. The salary attached to the office of Gas Examiner is £100 a year.

Applications must be addressed to the Clerk of the Metropolitan Board of Works, Spring Gardens, S.W. The latest time for receiving applications is 4 o'clock on Thursday, the 5th of October next.

J. E. WAKEFIELD, Clerk of the Board.

Spring Gardens, S.W., September 21st, 1882.

CHEMICAL PUPIL.

A Vacancy will occur in course of a month for a well educated Young Gentleman in one of the largest Laboratories in London. Premium 50 or 100 guineas, for a term of two or three years.—X. Y. Z., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

YOUNG CHEMIST FOR BRITISH GUIANA.

In consequence of the great number of applications for the above post, replies by letter can only be sent to selected candidates.—F.C.S., 18, Henrietta Street, W.C.

Wanted, by Advertiser, a Situation as Manufacturer in Chemical Works, well up in the manufacturing of Acids, Nitrates of Strontia and Baryta, and all Pyrotechnical and general Chemicals.—Apply, W., 26, St. Stephens Road, Tredegar Road, Bow, E.

UNIVERSITY COLLEGE, LONDON.

FACULTY of SCIENCE, including the Departments of ENGINEERING and CHEMICAL and MECHANICAL TECHNOLOGY.

The SESSION will OPEN on Tuesday, October 3rd.

For detailed Prospectuses of the Courses of Instruction, Exhibitions, Scholarships, &c., apply to the College, Gower-street, W.C.

TALFOURD ELY, M.A., Secretary.

THE LONDON HOSPITAL & MEDICAL COLLEGE, MILE-END, E.

The SESSION 1882-3 will commence on Monday, October 2nd, 1882, when an Introductory Address will be delivered at the College, by JONATHAN HUTCHINSON, Esq., F.R.S., Senior Surgeon of the Hospital, at 8.30 p.m., to be followed by a Conversazione, to which all past and present Students are invited. FOUR ENTRANCE SCHOLARSHIPS, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital Appointments are free. The resident appointments consist of Five House-Physiciancies, Five House-Surgeoncies, and one Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special Entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

MUNRO SCOTT Warden.

ST. MARY'S HOSPITAL MEDICAL SCHOOL, PADDINGTON, W.—OPEN SCHOLARSHIPS and EXHIBITIONS in NATURAL SCIENCE.

The Examinations for 1882 will be held on Monday, October 2nd, and following days. Candidates are requested to call upon the Dean, at 17, Great Cumberland Place, Hyde Park, on the morning of Saturday, September 30th, between the hours of eleven and one, and to bring with them the necessary certificates. For further particulars apply to the Medical Superintendent at the Hospital, or to

A. B. SHEPHERD, M.D., Dean of the School.

ST. MARY'S HOSPITAL MEDICAL SCHOOL, PADDINGTON, W.

The Introductory Lecture, by Dr. CHAMBERS, MONDAY, OCTOBER 2nd, 1882, at 3.30 p.m.

MEDICAL OFFICERS AND LECTURERS.

Consulting Officers—Dr. Chambers, Sir James Alderson, M.D., F.R.S., Mr. Lane, Mr. Spencer Smith, Mr. J. R. Lane, Mr. White Cooper.
Physicians—Dr. Handfield Jones, F.R.S., Dr. Sieveking, Dr. Broadbent.
Physicians in Charge of Out-Patients—Dr. Cheadle, Dr. Shepherd, Dr. Lees.
Surgeons—Mr. Haynes Walton, Mr. Norton, Mr. Owen.
Surgeons in Charge of Out-Patients—Mr. Page, Mr. Pye, Mr. A. J. Pepper.
Physician-Accoucheur—Dr. Alfred Meadows.
Physician-Accoucheur in Charge of Out-Patients—Dr. Wiltshire.
Ophthalmic Surgeon—Mr. Anderson Critchett.
Aural Surgeon—Mr. Field.
Surgeon-Dentist—Mr. Hayward.
Medical Tutor—Mr. Pepper.
Other Lecturers—Dr. Wright, F.R.S., Dr. Randall, Mr. Mivart, F.R.S., Rev. J. M. Crombie, Mr. Malcolm Morris.

The course of teaching at this School ensures careful and complete preparation for all the Examining Boards, the Public Services, and the higher University Examinations. Special instruction is given to Students preparing for the Examinations of the University of London.

The MEDICAL TUTOR assists the Students in their Clinical Work and in preparing for the Final Examinations, so that the training of every individual Student is supervised. Ophthalmic, Aural, and Dental Surgery, Comparative Anatomy, Histology, and Pathology are carefully and systematically taught both by Lectures and Practical Demonstrations. There are also departments for the Diseases of Women and Children, of the Eye and Ear, of the Skin, and of the Throat.

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These Scholarships are awarded every year by open competition in Natural Science previous to entrance at the School.

A Scholarship in £20 in Anatomy.

A Scholarship of £40 in Pathology, carrying with it the appointment of Assistant-Curator.

These are awarded annually.

PRIZES.

Prizes are given in each class at the close of every Session.

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Four House Surgeoncies, each tenable for one year.

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The NINTH SESSION begins Tuesday, October 3rd, 1882.

Mathematics and Experimental Physics (Lectures and Laboratory)	Professor A. W. RUCKER, M.A. Assistant Lecturer, C. SPURGE, B.A.
Chemistry (Lectures and Laboratory)	Prof. T. E. THORPE, Ph.D., F.R.S. Assistant Lecturer, C. H. BOTHAMLEY, F.C.S.
Geology and Mining	Prof. A. H. GREEN, M.A., F.G.S.
Coal Mining	Instructor, A. LUPTON, M.I.C.E., F.G.S.
Biology	Prof. L. C. MIALL, F.G.S., F.L.S. Assistant Lecturer, ALFRED DENNY.
Civil and Mechanical Engineering	Professor G. F. ARMSTRONG, M.A., F.G.S., C.E.
Classical Literature and Philosophy	Prof. N. BODINGTON, M.A.
Modern Literature and History	Prof. C. RANSOME, M.A.
French Language and Literature	Lecturer, JOHN WILLIS, Ph.D.
German and Oriental Languages	Lecturer, J. STRAUSS, Ph.D.
Textile Industries	Instructor, JOHN BEAUMONT.
Dyeing Department	Instructor, J. J. HUMMEL, F.C.S.

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SESSION 1882-83.

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A Diploma of Associate of the College is granted at the end of the Three Years' Course.

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The Fees are £2 for each Course, or £10 for all the Courses of each year, with the exception of Laboratory Practice.

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Descriptive Geometry, Drawing, Engineering, and Surveying—Professor PIGOT, C.E., M.R.I.A.
Experimental Physics (Theoretical and Practical)—Professor BARRETT, F.R.S.E., M.R.I.A.
Mining and Mineralogy—Professor O'REILLY, C.E., M.R.I.A.
Botany—Professor M'NAB, M.D., F.L.S.
Zoology—Professor HADDON, M.A., F.Z.S., Dean of Faculty.
Geology—Professor HULL, M.A., LL.D., F.R.S.
Palæontology—Mr. BAILY, F.L.S., F.G.S., M.R.I.A.

The Chemical and Physical Laboratories and Drawing School are open daily for Practical Instruction.

Fee for Chemical Laboratory, £2 for One month, £5 for Three months, £9 for Six months, or £12 for Session. Fee for Physical Laboratory, £1 per month, or £6 for Session. Fee for Biological Laboratory, £2 for the term. Fee for Drawing School, £3 for Session, or £2 for one term.

The SESSION COMMENCES on Monday, October 2.

Programmes may be obtained on application at the College; or by letter or post-card, addressed to the Secretary, Royal College of Science, Stephen's Green, Dublin.

Professor J. P. O'REILLY, Secretary, pro tem.

Mechanic's Institution & Literary Society, LEEDS.

CHEMICAL LABORATORY.

WINTER SESSION, 1882-83.

The EVENING CLASSES commence September 29th.

Teacher—Mr. GEORGE WARD, F.I.C., F.C.S.

Detailed Prospectus may be had on application.

THE CHEMICAL NEWS.

Vol. XLVI. No. 1192.

ON THE ACTIVITY OF OXYGEN AND THE MODE OF FORMATION OF HYDROGEN DIOXIDE.*

By C. T. KINGZETT, F.I.C., F.C.S.

In their endeavours to explain the production of ozone and hydrogen dioxide in certain processes of oxidation, most chemists have had recourse to the views promulgated by Thénard, Lamont, and others.

R. Lamont supposes† that the production of ozone by the atmospheric oxidation of phosphorus in the presence of water is connected with the uneven quantivalencies of the elements concerned in the reaction. He conjectures that the phosphorus first of all combines with two molecules of oxygen, and then, in order to form the pentoxide, a third molecule of oxygen is split up, leaving an atom of oxygen in the free state, and that this atom then combines with an ordinary molecule of oxygen to create a molecule of ozone. Similarly, Thénard regards peroxide of hydrogen as a product of the oxidation of water by the splitting up of the oxygen molecule into active atoms, one of which combines with and is retained by the water. By the oxidation of phosphorus over water, both ozone and peroxide of hydrogen are obtained as products of the reactions involved, whereas in the oxidation of turpentine and other terpenes over water, ozone does not appear as a product, but only peroxide of hydrogen.

As regards the first-named process, I would observe, in passing, that Lamont's theory is, as I have elsewhere pointed out,‡ faulty, since it does not explain the necessity of the presence of water. If water be absent then a distinct system of chemical changes obtains, thus proving that an explanation to be correct must extend to the water as also to the phosphorus and the oxygen. The oxidation of turpentine is a more simple process, from the point of view here taken, inasmuch as it yields only hydrogen dioxide, and, having been better studied, I propose to dwell rather upon its consideration than that of the other case, while examining some conclusions of M. Traube,§ who has recently experimentally investigated the subject of this communication.

M. Traube finds that when zinc or copper is shaken up with air and water, peroxide of hydrogen is formed, but not active oxygen, which, if present, would oxidise and decolourise indigo-sulphonic acid—a result that is not obtained. He further finds that hydrogen dioxide is alone produced by shaking up zinc with air and ammonia, and contends that no hypothetical active oxygen is obtained, since, if present, it would oxidise the ammonia to nitrite or nitrate, and neither substance is yielded. These results and others are viewed by Traube as satisfactory evidence of the fallacy of Thénard's theory. Curiously enough, however, he overlooks—at least he does not mention—the best existing proof of that for which he contends. This was furnished by my researches upon the oxidation of the terpenes, wherein it was shown‖ that turpentine, for instance, first of all simply absorbs the whole molecule of oxygen, just as Soret had shown it to absorb the whole molecule of ozone. There is no evidence of the splitting up of the oxygen or ozone molecules, but a total absorption takes place, resulting in both cases in the formation of an organic peroxide, which I conjectured might be identical with the camphoric peroxide ($C_{10}H_{14}O_4$), obtained otherwise by Brodie, and it is only by a secondary reaction between the oxidised turpentine and water that hydrogen dioxide is eventually obtained.

This is clear proof that molecular oxygen taking part in the oxidation of turpentine is not split up into atoms, and is presumptive evidence that it is not split up in the other process to which I have referred, viz., the oxidation of phosphorus.

To revert to the paper of M. Traube. He next proceeds to argue that in the formation of hydrogen dioxide it is water and not oxygen that suffers decomposition, and in confirmation of this view he mentions that the alkali metals, which remain unchanged in dry oxygen, readily decompose water. He also represents the production of peroxide of hydrogen by zinc, air, and water as follows:—

$$Zn + OH_2 + O_2 = ZnO + H_2O_2 \quad \text{and}$$
$$ZnO + OH_2 = Zn(OH)_2$$

It will be observed that these equations indicate the formation of one molecule of hydrogen dioxide for each molecule of metallic hydroxide produced, but M. Traube does not adduce any quantitative evidence of their correctness, but contents himself with the statement that Schönbein has established a similar relation in the case of lead at the beginning of the reaction. Traube's conjecture, then, is that zinc decomposes water by assimilating an atom of oxygen, and that the hydrogen thus set free simultaneously enters into combination with atmospheric oxygen to form hydrogen dioxide.

I have not yet investigated for myself the oxidation of metals in the manner described by M. Traube, but I feel great difficulty in accepting these views. That zinc should, by virtue of its affinity for oxygen alone, more easily decompose water than unite with free oxygen, is to me difficult of belief; nor can I understand the simultaneous combination of a molecule of hydrogen with one of oxygen taken from the air, as is assumed to take place. However that may be, M. Traube is not altogether happy in his selection of facts adduced for the purpose of lending confirmation to these views. He states, for instance, that the formation of hydrogen dioxide by the action of acids upon the metallic peroxides, does not involve the oxidation of water, but the interchange of the metal with the hydrogen of the acid. It seems to me that we may view at will the process as involving the one change or the other. Thus the action of sulphuric acid upon barium peroxide may be represented either as—

$$BaO_2 + H_2SO_4 = BaSO_4 + H_2O_2 \quad \text{or}$$
$$BaOO + H_2OSO_3 = BaOSO_3 + H_2OO.$$

As regards the action of hydrochloric acid it may of course be represented as—

$$BaO_2 + 2HCl = BaCl_2 + H_2O_2,$$

but this equation probably does not represent the actual changes, which may be, perhaps, more reasonably expressed thus—

$$BaO_2 + 2HCl = BaCl_2 + H_2O + O,$$

the peroxide of hydrogen only forming when water is also present, as it always is either attached to the hydrated barium peroxide, or present with the hydrochloric acid, or with both. That this is so, is supported by the decomposition of the barium peroxide in water by means of carbonic anhydride,

$$BaO_2 + H_2O + CO_2 = BaCO_3 + H_2O_2.$$

It is thus just as easy to understand the direct oxidation of water, always present, as to imagine the replacement of hydrogen by the metal; the only requirement is that water shall be present in chemical contact with the oxygen as and when it is rendered available.

In order to further test the idea of M. Traube, it may be useful to consider again by what steps hydrogen dioxide is obtained from peroxidised turpentine. This last

* Read before the British Association, Southampton Meeting, Section B, 1882.

† Chemical News, vol. xxviii., p. 236.

‡ Chemical News, vol. xli., p. 182.

§ *Berichte*, 15, 659-675; for abstract see *Journ. Chem. Soc.*, August, p. 795.

‖ *Journ. Chem. Soc.*, 1875, pp. 210-221.

named substance, by mere contact with water, yields peroxide of hydrogen. Here, oxygen is transferred from the organic peroxide to the water, speaking broadly, and it is not possible to conceive that in this simple process anything like the decomposition of water takes place. We have, probably, either a mere transference of oxygen or a simple re-arrangement of molecules.

In one of my papers (*Journ. Chem. Soc.*, 1875) I have represented the change as follows:—

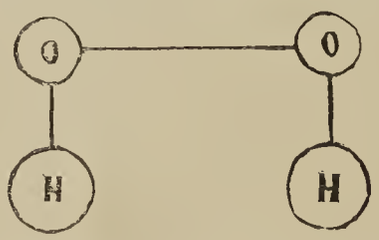
$$C_{10}H_{14}O_4 + 2H_2O = C_{10}H_{16}O_4 + H_2O_2.$$

In this equation I assumed the identity of my peroxide with Brodie's body, and endeavoured to explain why a camphoric acid was found present with the peroxide of hydrogen in my solution, and for those immediate purposes the equation well sufficed, even if it be not strictly correct.

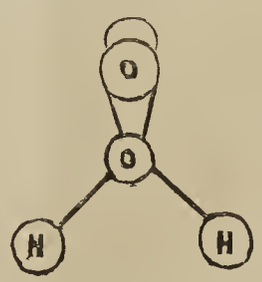
I will not seek to further apply the considerations arising from the study of the oxidation of turpentine to that of phosphorus, but will merely add that, so far, there exists considerable doubt as to the mode of formation of ozone and hydrogen dioxide in that process. Is hydrogen dioxide a secondary product in this system of changes? Probably it is, and probably ozone is also, and, if so, then from what substances do they result, and by what reactions?

The study of turpentine oxidation is at once, as I have said, more simple, and has been better studied, and we may rely upon our knowledge of the process as furnishing strong evidence against the erroneous idea that has been widely held concerning the splitting up of the oxygen molecule and of the fallacy of Traube's conjecture as constituting a general explanation of the mode of formation of hydrogen dioxide.

The study also leads to another and important consideration, and that is the constitution of hydrogen dioxide. In this substance are the atoms of hydrogen severally united with atoms of oxygen, thus?—



or has oxygen a variable adicity? In the latter case, representing oxygen as a tetrad, we might conceive hydrogen dioxide to be an oxide of water—a constitution much more in accordance with its properties, thus—



It is difficult to accept the ordinary formula, and to understand why one atom of oxygen is so readily given up by the compound while the other is so persistently retained, and there is a good deal of general evidence tending to show that the oxygen which is lost in such cases by the substance is the same oxygen as that which by its association with the water molecule, originally produced the peroxide of hydrogen. It is to be noted that although certain metallic oxides are reduced to the metallic state by admixture with peroxide of hydrogen, yet, as shown by M. Berthelot,* the oxygen set free in the case of silver oxide is only equal in amount to that present in the oxygenated water, the residual matter containing the whole of the silver and oxygen originally contained in the oxide of silver; but the distribution of the elements becomes changed under the action of the hydrogen dioxide, so that the residual compound represents a mechanical mixture, containing one-third of the silver in the reduced state and the corresponding portion of oxygen as sesquioxide of silver.

I think the facts to which attention has been directed in the foregoing remarks says nothing in favour of molecular connection as being something distinct from interatomic connection, but they seem to me to indicate that oxygen has a variable adicity or valency—a supposition which I feel more free to espouse, since Professor Odling, in his powerful address to the Chemical Society in February last, has reasoned so strongly in favour of the variable adicity of the chemical elementary substances, or (as I should prefer to style them) the various forms of matter.

* *Comptes Rendus*, No. 11, March 15, 1880.

REPORT OF THE COMMITTEE ON THE CALIBRATION OF MERCURIAL THERMOMETERS.

On Monday, August 28th, the Report of the Committee on the Calibration of Mercurial Thermometers was laid by Prof. Rücker before Section B of the British Association. Prof. Rücker said that as the report was lengthy, and would be in many parts unintelligible without reference to the Tables and Plates by which it was accompanied, he must ask to be allowed, instead of reading it in full, to give a general account of the work which had been done and of its results. The following is a full report of his remarks:—

In drawing up the Report the Committee have desired to present it in the form in which it will be most generally useful. It is therefore divided into two parts. The first contains a brief outline of the various methods of calibration hitherto proposed, and a summary of the results arrived at with regard to them by the Committee. This portion therefore contains the facts necessary to enable a selection from the various methods to be made by persons intending to undertake the calibration or correction of a thermometer. The second consists of a fully worked-out example of each of the methods, together with critical and other remarks of a detailed character. This part will, it is hoped, be useful in facilitating the calculations required, more especially as references to the subject of calibration in English scientific works are rare and meagre.

The corrections for the inequalities in the bore of a thermometer tube may be applied in two different ways, viz., by *calibration* or *correction*. In the first the tube is studied before the scale is etched on it, and the divisions of the scale are adjusted so as to make equal differences of scale readings correspond to equal tube volumes. In the second the tube is furnished with a uniform scale, and a table of corrections is afterwards prepared by which the same result is attained. A high degree of excellence can be obtained by the former method, which is generally employed by the makers. If, however, great accuracy is desired, all thermometers require correction, and if an instrument has been previously calibrated this process is rendered very laborious by the varying lengths of the divisions which have to be allowed for in the calculations. The results, too, are probably less accurate than they otherwise would be on account of the irregularity of the correction curves produced by the superposition of the errors of the tube and scale. The Committee therefore recommend the use of a uniform millimetre scale, and the employment of such tubes only as preliminary tests have shown to be of fairly uniform bore.

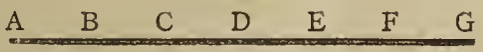
As all the methods of calibration and correction described depend upon the measurement of the length of

columns of mercury in various parts of the tube, it is important to decide upon the best method of separating these "threads" (as they are called) from the main mass of mercury in the tube and bulb. In general it is in the first place necessary to make the mercury "run" from the bulb into the tube, so that a column of any length can be obtained when the thermometer is at the ordinary temperature. To effect this the instrument should be held in a vertical position with the bulb uppermost, and the lower end of the tube should be cautiously tapped against the table. If the mercury does not run it is well, as a preliminary, to heat and cool the bulb several times. A change of temperature of a few degrees will generally suffice. The transference of the mercury from the bulb to the tube causes a vacuum bubble to appear in the former. If this is brought to the junction between the tube and bulb it is often possible, in a thermometer with a tolerably wide bore to effect a disruption of the mercury at this point by a dexterous jerk, and thus to break off a thread of the desired length. It is, however, exceedingly difficult, if not impossible, to apply this method satisfactorily to instruments with narrow bores; and in all the experiments undertaken by the Committee the separation of the thread was effected by heat. Some writers recommend the use of the blowpipe flame, which appears unnecessarily risky. The Committee employed a small flame, about four or five millimetres high, obtained from the gas issuing from a narrow orifice at the extremity of a piece of glass tubing drawn out fine. Into this the thermometer was introduced, care being taken to heat the tube equally all round, and the rupture was effected at the point where the heat was applied. It is easy thus to break off threads to within a millimetre of the length desired. When great accuracy is important it is advisable first to break off a thread longer than that required, and then to separate from it a portion of the desired length. Greater steadiness of the mercurial column while the thermometer is being heated is thus attained. Many dozens of thread have thus been broken off within the experience of members of the Committee without a single breakage of the instruments experimented on.

Methods of calibration and correction may be divided into four classes.

The first class contains what may be called the *step by step* method which is due to Gay-Lussac. In it a thread of mercury is measured in a position A B, then shifted to B C, then to C D, and so on through the whole length of the tube, the corrections being deduced from the variations in length.

FIG. 1.



The second class contains *principal point* methods. In these a number of principal points separated by an equal number of scale divisions are selected. The corrections are determined for these by means of threads, the lengths of which are approximately equal to, or multiples of, the distance between two consecutive principal parts. Several methods are included in this class. Hällström's, as described by Pfaundler, is a modification of Gay-Lussac's, in which an attempt is made to prevent the risk of the cumulation of errors inherent in the use of very short threads. Two threads are used, one twice, the other three times as long as the distance between two principal points. The first is measured in the positions (see Fig. 1) A C, B D, C E, &c., the other in the positions A D and B E only. From these measurements the corrections at A, B, C, &c., can be found.

In M. Thiesen's method (*Carl's Repertorium*, bd. xv.), the scale being divided into n parts by equidistant principal points, threads equal in length to 1, 2, 3 . . $n-1$ of these intervals are measured with the ends nearest to the bulb, coincident in turn with as many of the selected points as possible, and hence the corrections are deduced. Marek (*Ibid.*, bd. xv.) has applied the method of least squares to the calculation of the corrections of a number of selected points.

When by any principal point method the scale has been divided into a number of parts, the relative volume-values of which are known, it is of course possible to sub-divide these parts by a number of secondary points. In one method, however (Rudberg's), such sub-division is of the essence of the method, and it therefore constitutes the third class, or method of *repeated sub-division*. Thus (see Fig. 1) the tube is first divided into two equal parts by measuring a thread of about half its volume when it occupies approximately the positions A D, D G. These parts are then sub-divided into three by measuring a thread about one-third of the length of the tube in the positions A C, C E, E G, B D, and D F, and the process can then be carried further.

The last class may be called that of *distributed point methods*. Of these there is only one example, viz., Bessel's. In it the threads are measured with the end nearest the bulb coincident in turn with each of a series of selected points, but as the lengths of the threads are, within wide limits, arbitrary, the other ends do not coincide with the principal points, but are distributed more or less unevenly over the scale.

In the modification of this method adopted by A. von Oettingen ("Ueber die Correction der Thermometer Dorpat," 1865) eight or ten threads are used, and the corrections are finally found by a graphic method. The scale divisions being taken as abscissæ, and the corrections to be applied to them as ordinates, each thread furnishes a correction curve. The curve obtained by taking the mean of the ordinates of these is the final correction curve. This method is in the report subjected to full and detailed criticism. It is open to the objection that by it the ends of the tube are less accurately corrected than the centre. This is especially unfortunate. Thermometers are now often made with scales so open that it requires several to cover the whole range of temperature from 0° to 100° C. Each instrument therefore can have at the most but one fixed point, and to determine the value of a scale division in degrees it is necessary that each thermometer should overlap those above and below it, so that they can be compared over a considerable range of temperature. This range is, however, seldom more than one-fourth of that over which the scale of each thermometer extends, and thus any error which occurs in the determination of the relative value of this overlap in two instruments is magnified in its effects upon the absolute readings of each. It is then important that the ends of such thermometers shall be corrected with especial care, and Profs. Thorpe and Rücker have introduced some changes into Von Oettingen's method of procedure which diminish this defect. The two methods are fully compared in the Report.

In many methods of calibration and correction one or both ends of the thread are, when it is measured, assumed to occupy certain definite positions on the scale. The condition that both ends should occupy their theoretical position could only be fulfilled in a perfectly uniform tube; otherwise, if satisfied in one part it would fail elsewhere. It is, however, often inconvenient even to comply with the condition that one end shall occupy a certain position. If the tube is graduated, and the position in question is indicated by a graduation, the breadth of this is often so considerable that the required accuracy of adjustment cannot be attained if the end of the thread is hidden behind it. Hence it is often better merely to bring the thread end to within a small but accurately measured distance of its theoretical position. The error thus committed can then be allowed for either by means of a second approximation, or by the use of a preliminary correction curve obtained by any simple method. The Report contains full details and examples of these two methods of procedure.

Formulæ are given which express the probable error of the correction of a principal point (E) in terms of the

probable error of a thread length (e). If $E = m^2 e$, the numbers in Table I. gives the values of m^2 for ten principal points 4° apart, when the methods referred to are employed to find the corrections at them. These numbers are inversely proportional to the theoretical weights which should be assigned to the correction of a point determined by any method if it is to be combined with a similar correction determined by another method.

Thus in the case of Gay-Lussac's method, the value of the correction of a point is, *cæteris paribus*, proportional to the length of the thread used in obtaining it. Rudberg's method corrects the instrument best in the middle,—Gay-Lussac's at the ends. Thiesen's method has the advantage that the value of the corrections is uniform throughout the scale, Hällström's the grave disadvantage that it is very irregular, and that the errors accumulate in an extraordinary way on two of the points.

TABLE I.

Squares of Probable Errors of Principal Points.

Point.	Gay-Lussac. Thread 2° long.	Gay-Lussac. Thread 4° long.	Rudberg.	Hällström.	Thiesen.	Bessel.
0	0·0	0·0	0·0	0·0	0·00	0·00
1	1·8	0·9	1·4	1·1	0·18	0·10
2	3·2	1·6	1·8	0·8	0·18	0·10
3	4·2	2·1	0·7	1·1	0·18	0·10
4	4·8	2·4	0·6	1·2	0·18	0·09
5	5·0	2·5	0·5	2·5	0·18	0·09
6	4·8	2·4	0·6	1·2	0·18	0·09
7	4·2	2·1	0·7	4·3	0·18	0·10
8	3·2	1·6	1·8	0·8	0·18	0·10
9	1·8	0·9	1·4	6·5	0·18	0·10
10	0·0	0·0	0·0	0·0	0·00	0·00

It must be remembered that the numbers in this Table apply only to the case of the determination of ten principal points, and that in calculating them no allowance is made for inaccuracies introduced by assumptions, which are only approximately true, made in the methods themselves.

The experimental work of the Committee has been performed upon twelve thermometers. Two sets of three belonging to Profs. Thorpe and Rücker were made by Casella. The other two sets were made in the Kew Observatory and in the Physical Laboratory of the Owens College respectively. The length of a degree in the different instruments varied from 9 to 13 m.m.. and may therefore, in round numbers, be taken as equal to a centimetre.

The Kew thermometers were calibrated according to Welsh's (Gay-Lussac's) method, a good dividing engine being employed. After the scale was etched the same instrument was employed to make all the measurements necessary for the application of Bessel's method to the thermometer. The result of this severe test was reported to Section A last year, viz., that the maximum error barely exceeded 0·01°, and in two of the thermometers fell much below this amount.

The Committee have also tested the various methods by applying them all to the same thermometer, an instrument reading from 98° C. to 142° C. The measurements were made in the Physical Laboratory of the Yorkshire College, partly by Prof. Rücker, partly by Mr. W. Heaton, Demonstrator in the Clarendon Laboratory of the University of Oxford, who spent some time in Leeds for the purpose of assisting in this rather laborious task. Gay-Lussac's method was applied three times, the thread lengths being 1·6°, 2·0°, and 4·0° respectively. The curve obtained by means of the thread 2·0° long was used as above explained as a preliminary curve to allow for the errors introduced in the other methods by the fact that the thread ends did not always occupy their theoretical positions.

The instrument employed was that devised by Mr. F. D. Brown, and described by him in a recent number of the *Philosophical Magazine* (June, 1882). Readings could be made on the vernier to 0·1 m m., and by estimation to 0·02 or 0·03 m.m. The probable error of the measures made for the application of Bessel s method, 138 in number, was 0·025 m.m. The Committee thought it well to employ this instrument, as if satisfactory results were obtained its comparative simplicity and cheapness would enable many persons to correct their thermometers who had not the opportunity of using a dividing engine. The result of the investigation showed that it is capable of giving very good results. The following Table gives in thousandths of a degree the corrections obtained for the principal points by the methods indicated. Rudberg's method cannot be directly compared with the others, as it was used to find the corrections at 12 points.

TABLE II.

Corrections given by Different Methods in Terms of 0·001°.

	Gay-Lussac, Thread Length. 1·6°,	2·0°.	4·0°.	Hällström.	Thiesen.	Marek.	Bessel.
100	0	0	0	0	0	0	0
104	121	120	116	120	121	—	120
108	155	155	151	153	156	155	151
112	106	109	104	107	109	—	104
116	108	116	113	115	117	117	115
120	130	136	135	137	138	—	135
124	106	112	111	109	113	112	109
128	108	111	111	114	112	—	108
132	56	60	61	56	61	62	54
136	2	10	12	13	10	—	4
140	0	0	0	0	0	0	0

In estimating the value of the agreements between the various columns in this Table it must be remembered that whereas the two first Gay-Lussac corrections and those given by Bessel's method are quite independent of the others, observations on the same threads were employed in the other methods. All the measurements, for instance, worked up according to Marek's formulæ were also employed in the calculations required in Thiesen's method. It will be seen that the difference between the corrections for the same point only in one instance exceeds 0·01°.

On the other hand, the amount of labour involved in the different methods is very different. Gay-Lussac's method can be applied in a few hours: the observations and calculations necessary for Bessel's occupy six or seven days.

The following Table gives the number of actual measurements required in such method.

TABLE III.

Method.	No. of Measures Required. (1) Principal Corrections.	(2) Preliminary Curve.	(3) Total.	No. of Points Corrd (1) Principal Corrections.	(2) Total.
Gay-Lussac I.	26	—	26	26	26
,, II.	20	—	20	20	20
,, III.	10	20	30	10	20
Hällström	11	20	31	10	20
Thiesen	54	20	74	10	20
Marek	14	20	34	5	20
Rudberg	15	20	35	12	31
Bessel	138	—	138	148	148

A detailed discussion of the results arrived at by the different methods, awards, on the whole, the palm to Bessel's, but the Committee consider that equally good results can be obtained with much less labour by repeating Gay-Lussac's method with two or three threads of different lengths, and taking the mean of the curves so obtained. Thus, the mean of the numbers in the first two columns of Table II. nowhere differs from the corresponding number in the last column by 0·005° (0·05 m.m.)

The Committee, for convenience, finally define three standards of accuracy, viz., that the corrected scale shall at no point be in error by 0·1, 0·05, and 0·02 m.m. respectively. In the thermometer used these would correspond

to about 0·01°, 0·005°, and 0·002°. They consider that 0·05 m.m. is about the limit of the error of an unassisted-eye reading, and that the second standard is therefore that which will be most generally aimed at for very accurate work. The Report contains details of the methods which the Committee think suited to attain each of these standards with the least trouble. In brief, they state that the first can be reached by a calibration by Gay-Lussac's method conducted with a dividing engine, the second by correcting according to Bessel's method or by the mean of two of Gay-Lussac's curves when the measurements are made with Mr. Brown's instrument, the third can be attained only by the most elaborate methods and apparatus. On the whole, therefore, the result of the investigation is in favour of the repetition of the less elaborate rather than of the use of the more theoretically perfect methods.

THE ACTION OF WATER ON LEAD.

By ALFRED H. ALLEN.

THE article in the CHEMICAL NEWS, vol. xlvi., p. 88, gives an epitome of the recent action by Mr. J. J. Milnes against the Huddersfield Corporation.

As therein stated, at the trial there arose the question of the influence the presence of sulphuric acid had upon the tendency of water to act on lead, and in the words of the article "the water in question was admitted to have an acid reaction. This was due to sulphuric acid, as was shown by Dr. Tidy." I was not present in court while Dr. Tidy's evidence was being taken, and have seen no published account of his examination, but, seeing that the proportion of free acid was very small, it would be interesting to learn how it was proved to be *sulphuric* acid. That a free acid was present was proved by the fact that the water distinctly reddened a solution of Poirier's orange, and, after concentration, had a distinctly acid reaction to litmus; but it seems very improbable that the trace of acid present was recognisable by its charring action, and, if not, how was it proved to be sulphuric acid? That the free acid originated in the influx of ochreous water containing free sulphuric acid seems to be admitted, but what becomes of free sulphuric acid when added to a water containing several times its equivalent of metallic chlorides? It may reasonably be argued that sulphates are formed, together with free hydrochloric acid, and, until this view is experimentally disproved, most chemists will regard it as probably correct.

Now the presence of a small quantity of free hydrochloric acid admittedly increases the tendency of water to act on lead, and is probably the cause of the influence observed in the case of the Huddersfield water. But, on the other hand, "Dr. Tidy, Prof. Odling, and Mr. Crookes were of opinion that sulphuric acid, if present in small quantities, must tend to protect the pipes from the action of the water, a thin layer of the insoluble, or at least very sparingly soluble, lead sulphate being formed." How far it is reasonable to expect that such protection would be exerted by very small proportions of sulphuric acid may be gathered from a consideration of the relative solubilities of the oxide, carbonate, and sulphate of lead in distilled water, thus,—

			Pb per Gallon.
1 part of PbO	dissolves in	7000 parts of water	= 9·8 grs.
1 ,, $PbCO_3$	,,	50,500 ,, ,,	= 1·07 ,,
1 ,, $PbSO_4$	,,	22,800 ,, ,,	= 2·09 ,,

I am unable to find the solubility of basic lead carbonate, but it is probably less than that of the neutral salt.

It appears, then, from these figures, that distilled water in contact with lead and oxygen might take up 9·8 grs. of lead per gallon, but in presence of carbonic acid, as in most natural waters, this would be reduced to 1·07 grs. In presence of free sulphuric acid, however, shown by Dr. Tidy to be present, the carbonate would be changed to sulphate, and the possible amount of lead in solution would be *nearly doubled*. It is true that in presence of a very large excess of sulphuric acid (sufficient to convert the water into "dilute sulphuric acid") the solubility of lead sulphate is somewhat diminished, but that is a state of affairs which does not apply to the Huddersfield water, respecting which the three high scientific authorities quoted expressed an opinion leading the jury to infer that the presence of a trace of free sulphuric acid was rather beneficial than otherwise, as it would "tend to protect the pipes from the action of the water."

But experiment on such a subject is better than theory, and hence I submit the following data on the action on lead of water containing different amounts of free sulphuric acid. The experiments were made by adding to four quantities of 250 c.c. of distilled water a definite volume of decinormal sulphuric acid (= 4·9 grms. H_2SO_4 per litre). Pieces of sheet lead of equal size, scraped clean immediately before use, were then immersed in the liquids, and the beakers loosely covered and left over night.

Expt. I.—Distilled water without any addition of sulphuric acid acted strongly on the lead. The metal was removed, and the white deposit at the bottom of the beaker was dissolved in a few drops of hydrochloric acid, when the water was found to contain 7 grains per gallon of metallic lead.

Expt. II.—To 250 c.c. of distilled water 0·1 c.c. of decinormal sulphuric acid was added. This corresponds to 0·112 grain SO_3 per gallon, or about the quantity of free acid found by Mr. Fairley in the Huddersfield water. The experiment was conducted as in I., when 7 grains of Pb were found, as in the previous case.

Expt. III.—The sulphuric acid was increased to 1·0 c.c. = 1·12 grains free SO_3 per gallon. The lead appeared little acted on, there being no formation of carbonate, but the water was found to contain 1·75 grains of lead per gallon.

Expt. IV.—5·0 c.c. sulphuric acid added, = 5·6 grs. SO_3 per gallon. No apparent action on the lead, but the water contained 1·70 grains Pb per gallon.

In the first two experiments it must be remembered that in the absence of sulphuric acid the lead was converted into carbonate, and hence was not really in solution in the water, but in experiments III. and IV. it existed as dissolved sulphate.

These experiments were made with distilled water, and consequently under conditions that do not exist in practice. Hence the following experiments are of more real value. They were made side by side with those already described, but Sheffield water was substituted for distilled water. Sheffield water is a pure moorland water containing from 5 to 7 grains per gallon of total solids, of which the chlorine is 0·7 grain. The reaction is neutral, or very faintly acid rather than alkaline.

Expt. I.—Sheffield water without any addition of acid took up a trace of lead, less than 0·05 grain per gallon. (In a subsequent experiment 0·10 grain was dissolved.)

Expt. II.—With an addition of 0·112 grain per gallon of SO_3, a strong trace of lead was dissolved, notably more than in Expt. I.

Expt. III.—With 1·12 grains SO_3, 0·28 grain of lead was dissolved.

Expt. IV.—With 5·6 grains SO_3 per gallon, the lead dissolved was 4·9 grains per gallon.

In none of these experiments was there any sensible formation of carbonate, and only the clear liquid was used for the determination of lead. It will be seen that the presence of sulphuric acid, even in very small quantity, notably increases the tendency of the water to act on lead. Repetition of the experiments always furnishes results pointing in the same direction, but the actual figures vary from time to time, being probably influenced by variations in the composition of the water. Thus, previously to the trial, I found the addition of 0·224 gr. SO_3 to 1 gallon of

Sheffield water caused the solution of 0·6 grain of lead per gallon in twenty-four hours, though the unacidulated water dissolved a barely perceptible trace of lead in the same time. It was to this experiment I referred in court as proving that the addition of a trace of sulphuric acid to a pure water (not distilled water) increased its tendency to act on lead.

Since the date of the trial a death has occurred at Keighley, which is suspected by the medical men to be due to lead poisoning through the medium of water. The deceased was in the habit of drawing a glass of water from the tap the first thing in the morning, and by drinking this he would necessarily introduce into his system any lead dissolved from the pipes during the night. In his viscera I found lead. Water which had been standing in the lead pipes all night contained 0·61 grain of lead per gallon. Water taken from the neighbouring main was free from lead, but had a marked acid reaction to Poirier's orange. Left over-night in contact with clean lead it dissolved from 0·42 to to 0·56 grain per gallon. Rendered faintly alkaline with lime-water, and left over-night in contact with lead, only 0·14 grain of Pb was dissolved.

These experiments appear to me to indicate that a trace of free acid is a leading cause of the action of water on lead, and that the effect can be greatly diminished by neutralisation.

Occasionally, during a period extending over many years, I have examined the Sheffield water for lead. At present it is wholly free from that metal, even after standing over-night in the pipes, but not unfrequently I have found notable traces of lead. In the light of recent researches it is probable that, on those occasions, the water as delivered from the mains contained a free acid, whether sulphuric acid, or, as I contend is more probable, hydrochloric acid.

Of course the few experiments above described do not wholly clear up the difficult and obscure problem of the cause of the action of water on lead, but they at least indicate the great probability of one of the leading causes, and they help to lay at least one old ghost, and lead to a better understanding of some misinterpreted observations. It remains for others to show why sulphuric acid and sulphates should be theoretically held to reduce the tendency of water to act on lead when lead sulphate is more soluble than the carbonates, and why free sulphuric acid should be assumed to exist in water simultaneously with metallic chlorides.

Sheffield, September 9th, 1882.

Schools of Chemistry, &c.—The following information was received too late for insertion in our Students' Number:—

Metallurgical Branch of the Royal School of Mines.—This department will re open on the 2nd of October in a new lecture room and museum, which has been specially arranged for this class by the Science and Art Department at South Kensington. The Theoretical Course will consist of about sixty lectures, by Prof. W. Chandler Roberts, F.R.S., who is now making a careful inspection of the Mining Schools at Freiberg and at Leoben. The third award of the "Bessemer" Medal, and a prize of books, will be made at the end of the Session, in June, 1883. The Practical Course of Assaying is continued throughout the entire Session.

Burslem and Tunstall Schools of Science and Art, Wedgwood Institute, Burslem.—Lecturer on Chemistry, Physics, &c., W. A. Humboldt Sexton. Day lectures on Chemistry on Tuesdays and Thursdays at 2.30, and practical instruction in Laboratory after each lecture. October 3rd to Christmas—The Non-metallic Elements. January to March—The Metals. April to June—Organic Chemistry. Technical lectures on Saturday afternoon: Fuel at 3 o'clock; Pottery at 4 o'clock; Metallurgy at 5 o'clock. Evening Classes in Chemistry, Physics, and other subjects.

CHEMICAL LITERATURE.

An Address Delivered before the American Association for the Advancement of Science, at Montreal, August 23, 1882.

By Prof. H. CARRINGTON BOLTON, Ph.D., Vice-President.

(Continued from p. 117).

Among the fabulous writings, highly esteemed by the credulous alchemists, may be mentioned the celebrated inscription of Hermes Trismegistus upon an Emerald Tablet,* the Golden Leaves of Abraham, Jew Prince, Priest, Levite, Astrologer and Philosopher, which, in the hands of Nicolas Flamel,† yielded such a rich harvest, the Practical Chemistry of Miriam, the sister of Moses,‡ and a multitude of grotesque writings ascribed to personages of known reputation. Raymond Lully is credited with five hundred works; Hermes Trismegistus, the mythical Father of Sciences, with several thousand.

Many of the alchemical works published during the period of which we speak are degraded by admixture of the contemporaneous, pseudo-sciences, judicial astrology, and magic. To this class belong the celebrated works of Dr. Fludd and the writings of the Rosicruscians; excluding these as wholly beneath our consideration the number of occult works on alchemy is still very large. We imagine it will be hard to discover in the whole range of literature writings having scientific pretentions more senseless than the aphorisms of the disciples of Pythagoras, collected in the "Turba Philosophorum,"§ so often quoted by the alchemists of the sixteenth and seventeenth centuries. Its improbable character is perhaps equalled by the "Gloria Mundi," in which the anonymous author favours his readers with the chemical views of Aristotle, Plato, Socrates, and Democritus, interspersed with equally authentic statements by Hermes and Morien, Lamech and Methuselah, Abel and Seth, and even of Adam himself.‖

In the early part of the seventeenth century, Michæl Maier, physician to the Emperor of Germany, Rudolph II., a royal patron of astrologers and alchemists, published several treatises now much sought after by alchemical bibliophiles.¶ Maier's "Symbola aurea mensæ," and "Atalanta Fugiens," contain emblematic plates, supposed to illustrate the hermetic interpretation of the fables and allegories of Egypt and Greece.

The connection between these ancient mythologies and the secrets of the philosopher's stone was a favourite subject with many authors, and has been exhaustively treated by the Abbé Pernety in his two curious works, "Fables Egyptiennes et Grecques dévoilées," and "Dictionnaire Mytho-hermétique."** Not content with prose, several authors clothed their alchemical inspirations in poetry; of these may be mentioned the Arabian treatises already named, the Twelve Gates of Alchemy by Sir George Ripley, written about 1450,†† the Crede Mihi of Thomas Norton, written about 1477,‡‡ and the Chrysopœia of Aurelius Augurelli.§§ The latter written in

(Works marked (*a*) are in the private library of the author).

* Cf. (*a*) Thomas Thomson, "History of Chemistry," London, 1830, vol. 1, p. 10.

† Cf. (*a*) Nicholas Flammel, "His Exposition of the Hieroglyphicall Figures." London, 1624.

† In the Collection of (*a*) Johann Hoppodam, Wien, 1740, also in Barrett's Lives, *loc. cit.*

§ Cf. (*a*) Mangetus, *Bibliotheca chemica curiosa*, vol. 1, p. 400, also (*a*) *Bibliothèque des Philos. Chimiques*. vol. 2, p. 1.

‖ *Gloria Mundi, seu Tabula Paradisi*, in (*a*) *Museum Hermeticum*, p. 203.

¶ Michael Maier, (1) (*a*) *Tripus aureus*. Francofurti, 1618; (2) (*a*) *Viatorium hoc est de Montibus Planetarum septum*. Oppenheim, 1618; (3) (*a*) *Symbola aurea mensæ*. Francofurti, 1617; (4) (*a*) *Secretioris naturæ secretorum scrutinium chymicum per . . . Emblemata*. Francofurti, 1687.

** Antoine Joseph Pernety, (*a*) *Dictionnaire Mytho-hermétique*. Paris, 1787. Idem, (*a*) *Les Fables Egyptiennes et Grecques devoilées*, Paris, 1758. 2 vols.

†† (See ‡‡, next column).

‡‡ (*a*) Mangetus, *Bibl. chem. cur.*, II., 285, and in *Museum Hermeticum*, p. 433.

§§ Mangetus, *Bibl. chem. cur.*, II., 375.

Latin hexameters with more pretensions to elegance than usual with the prosaic alchemists was dedicated in 1514 to Pope Leo X. Leo rewarded Augurelli by presenting him with an empty wallet, remarking that one who knew so well how to make gold had need only of a purse.

The alchemists, in common with their contemporaries in other branches of literature, took pleasure in prefixing to their essays eccentric titles; Helvetius writes of "The Brief of the Golden Calf (The World's Idol) discovering the rarest Miracle in Nature;"* Glauber names one of his treatises, "The Golden Ass well managed and Midas restored to reason."†

Perhaps the height of absurdity is reached in the famous *Liber Mutus*,‡ which consists of a series of fifteen symbolic engravings purporting to disclose the whole Hermetic Philosophy. The utterly unintelligible character of much alchemical literature is occasionally acknowledged by those who otherwise accepted the prevailing popular belief in transmutation; Lenglet du Fresnoy, speaking of Raymond Lully's Clavicula, says, "Lully assures us that this treatise is indispensable to the comprehension of his writings; but, after reading it, one is little wiser than before."§

There are several large collections of alchemical treatises which the curious in these matters should consult; the most extensive is Zetzner's Theatrum Chemicum,‖ published in 1613 in six octavo volumes; this contains no less than 209 distinct treatises, notwithstanding which Lenglet du Fresnoy remarks that many excellent ones are wanting. Manget's Bibliotheca Chemica Curiosa,¶ published in 1702 in two folio volumes, contains 133 treatises, and the Musæum Hermeticum** (1678) contains 21 treatises, some of which are illustrated. The most extensive English collection is Ashmole's Theatrum Chimicum Britannicum, published in 1652, and a noted French collection is Salmon's Bibliothèque des Philosophes Chimiques (1672), of which the edition by Richebourg (1741) is by far the best.††

Stimulated by avaricious hopes, the zealous alchemists laboured most industriously; and, by subjecting mixtures of all known subtances to heat and to the action of acids, discovered a multitude of new bodies having more or less medical and economic value. As we have seen, their writings consist for the most part of monographs describing disconnected experiments, with no attempt at exhaustive treatment of any single topic, no classification of phenomena and no well studied arrangement of material such as characterises later handbooks. Nor can a scientific collocation be expected during the formative period of chemistry, and previous to the introduction of theories around which to group the isolated phenomena. One of the earliest attempts to treat chemical facts in a systematic manner was made by Sir George Ripley, Canon of Bridlington, who lived in the fifteenth century. In his "Compound of Alchemy," written in 1471, the whole science of hermetic chemistry is unfolded in a poem divided into twelve sections called "Gates," through which the reader is conducted to the mysteries of transmutation.‡‡

"But into chapters thys Treatis I shall devyde,
In numbre twelve, with dew recapytulatyon;
Superfluous rehearsalls I lay asyde,
Intendyng only to give trew informatyon
Both of the theoryke and practicall operatyon:
That by my wrytyin who so wyll guyded be,
Of hys intente perfyctly speed shall he.

The fyrst chapter shall be of natural Calcination;
The second of Dyssolution, secret and pholosophycall;
The third of our elementall Separation;
The fourth of Conjunction matrimonial;
The fyfth of Putrefaction then followe shall;
Of Congelation Albyficative shall be the sixt,
Then of Cybation, seaventh shall follow next.

The secret of our Sublymation the eyght shall show;
The nynth shall be of Fermentatyon;
The tenth of our Exaltation I trow.
The elevent of our mervelose Multiplycatyon,
The twelfth of Projection; then Recapitulatyon,
And so this treatise shall take an end,
By the help of God, as I entend.

* * * * * * *

Thus here the Tract of Alchemie doth end;
Which tract was by George Ripley, Chanon, penn'd.
It was composed, writt and signed his owne,
In anno twice seaven hundred seaventy one.
Reader, assist him, make it thy desire,
That after life he may have gentle fire! Amen.

Ripley's versification and theme remind one of Chaucer's Canon's Yeoman's Tale composed nearly one hundred years earlier.

We can only briefly allude to Paracelsus's bombastic productions,* which are concerned chiefly with medical chemistry, and to the remarkable works of George Agricola,† distinguished by profuse illustration, portraying the apparatus and operations of mining and metallurgy in the sixteenth century.

Conspicuous for accuracy of description and systematic arrangement of topics is the "Alchymia" of Andrew Libavius, published at Frankfurt in 1595.‡ Libavius, a physician and teacher in the gymnasium at Coburg, rejected the absurd doctrines of the adherents of Paracelsus, combated superstitution and quackery and, excelling in observation of chemical phenomena, gained a worthy position among his compeers. In his Alchymia he treats of the *Encheria* or manual operations of chemistry, and of the *Chymia* or descriptions of substances, in separate books. The former he divides into two sections, one dealing with the instruments and the other with the management of fires and construction of furnaces. He describes at length a sumptuous laboratory provided not only with every requisite for chemical experimentation, but also with means of entertaining visiting guests, including such luxuries as baths, enclosed corridors for exercise in inclement weather, and a well stocked wine-cellar.

Libavius was the discoverer of stannic chloride which still bears the name "fuming liquor of Libavius;" he describes the method of preparing artificial gems by colouring glass with divers metallic oxides, and he seems to have been the first to apply the balance to the examination of mineral waters. Notwithstanding his progressive position he devotes eighty pages of his Commentary to the Philosopher's Stone, in which he was a firm believer. The second edition of his works, published in 1606, forms a folio of 800 pages. It has sometimes been called the First Text-book of Chemistry.

* *Idem*, I., 196; also an (*a*) English Translation published by William Cooper. London, 1673.

† Bound with the preceding. Cf. also many titles in these notes.

‡ (*a*) Mangetus, *Bibl. chem. cur.* Vol. I., *ad finem.*

§ [Lenglet du Fresnoy], (*a*) *Histoire de la Philosophie Hermetique.* Paris, 1751. Vol. 3., p. 214.

‖ (*a*) *Theatrum chemicum præcipuous selectorum auctorum tractatus de chemiæ, &c. Argentorati, sumptibus* H. Eberh. Zetzneri, 1659. 6 vols. 8vo. [Second Edition].

¶ (*a*) J. J. Mangetus, *Bibliotheca chemica curiosa.* Geneva, 1702. 2 vols., fol.

** (*a*) *Musæum hermeticum reformatum et amplificatum.* Francofurti, 1678. Small 4to.

†† (*a*) J. R[ichebourg], *Bibliotheque des philosophes chimiques*, Paris, 1741. 3 vols., 12 mo. Cf. also, (*a*) Albineus's *Bibliotheca chemica contracta*, Genevæ, 1654; (*a*) Philippum Morgenstern, *Das Buch von der guldenen Kunst*, Basel, 1613: and (*a*) Johann Hoppodam's Collection. Wien, 1783.

‡‡ *Liber duodecim Portarum*, in Mangetus's *Bibl. chem. cur.*, II., 275. See also Kopp's *Geschichte der Chemie.* II., p. 9.

* Paracelsus's writings number three hundred and sixty-four on a great variety of subjects. His collected works were published at Basel in 1589 in 4to., and at Strasburg in 1605, fol.

† George Agricola, (*a*) *De Re Metallica*, Libri XII. Basiliæ, 1556.

‡ (*a*) Andrea Libavius, *Alchymia recognita emendata . . . tum commentario medico-phys-chymico.* Francofurti, 1606, fol.

The "Tyrocinium Chymicum" (1608) of Jean Beguin,* Almoner to King Louis XIII. of France, is a less pretentious work, characterised by freedom from ambiguity and prolixity as well as from hermetic superstitions; it deals chiefly with the medical applications of chemistry.

In 1660, Nicolas le Febvre, demonstrator of chemistry at the Jardin des Plantes, published a "Traicté de la Chymie,"† greatly superior to all preceding works of its kind. He collected the most reliable theories and experiments from all published sources and arranged them in a logical, systematic manner. The first six chapters treat of the theory of chemistry; the author admits five elementary principles: phlegm (or water), spirit (or mercury), sulphur, salt and earth, the first three being ingredients of volatile substances, and the latter those of refractory bodies. He defines metals as hard bodies generated in the bowels of the earth, capable of extension under the hammer, and of being melted by fire. He divides metals into the perfect and the imperfect, and also into male and female, the latter subdivision being based upon their behaviour with acids; gold, lead, and antimony are male metals, because soluble only in aqua regia, and the other five, silver, copper, iron tin, and mercury, are female, because soluble in unmixed acids.

In the second part the author discusses the manipulations of chemistry and recognises many nice distinctions now overlooked; for example, under the head of mechanical division he describes in detail the following operations: "limation, rasion, pulverisation, alcoholisation, incision, granulation, lamination, putrefaction, fermentation, maceration, fumigation both dry and humid, cohobation, precipitation, amalgamation, distillation, rectification, sublimation, calcination both actual and potential, vitrification, projection, lapidification, extinction, fusion, liquation, cementation, stratification, reverberation, fulmination or detonation, extraction, expression, incineration, exhalation, digestion, evaporation, desiccation, circulation, congelation, crystallisation, fixation, volatilisation, spiritualisation, corporification, mortification, and revivification."

In the experimental part Le Febre explains the arrangement in the following language:—

"We shall begin with the meteoric bodies, rain, dew, honey, wax, and manna; we shall then describe the preparations made from animals and their secretions; next, the numerous products of the vegetable world; and lastly, the mineral kingdom with its stones, salts, marcasites, and metals;" a division still recognised.

The order in which he treats mineral chemistry is as follows:—Earths; stones, precious and otherwise; metals; semi-metals; embracing mercury, antimony, and bismuth; salts, including common salt, saltpetre, alum, sal-ammoniac, and the vitriols; and lastly, the sulphuretted minerals, arsenic, &c. Under each division he gives precise instructions for numerous experiments upon these substances and describes their medicinal value. The whole work is written in a clear style, free from affectation of mystery; it rapidly passed through five editions, and was translated into English and German.

Three years after the appearance of Le Febvre's Traité, his successor at the Jardin des Plantes, Christopher Glaser,‡ of Basle, published a work having the same title olso marked by special excellence.

The most successful handbook of the seventeenth century was undoubtedly the "Cours de Chymie," by Nicolas Lemery,§ an eminent lecturer in Paris. The first edition of this work was published in 1675, and it reached the tenth edition before the close of the century; a fourteenth edition enlarged by Baron appearing as late as 1756. It was also translated into English (1677), German (1698), Italian (1763), and Spanish. The remarkable success of this work is due to a facility for describing dry facts with remarkable simplicity and accuracy. His style is more concise than Le Fevre's, and his arrangement of material shows a progressive spirit. The limits of this address forbid an analysis of Lemery's Handbook, which, moreover, is better known than some others to which we have granted fuller treatment.

(To be continued.)

* (*a*) John Beguinus, *Tyrocinium Chymicum*, or "Chymicall Essayes acquired from the Fountaine of Nature." [London], 1669, 12mo.

† (*a*) Nicolas Le Febvre, *Traicte de la Chymie*, Leyde, 1669. 2 vols. 18mo.

‡ Christopher Glacer, *Traite de la Chymie*, Paris, (?), 1663.

§ Nicolas Lemery, *Cours de chymie*, 1675. The editions examined were the (*a*) translation of the first edition, by Walter Harris, London, 1680; the (*a*) 11th, Paris, 1730; and the (*a*) 14th edition, Paris, 1756

CORRESPONDENCE.

CALCIC HYPOCHLORITE.

To the Editor of the Chemical News.

Sir,—To Mr. Kingzett's question (Chemical News, vol. xlvi., p. 120) I beg to reply as follows: In pursuance of the correspondence we had in your columns last year, I caused Dr. Schæppi to make repeated endeavours, both with English and Swiss bleach, to obtain crystallised calcium hypochlorite. Although he followed as closely as possible the rules laid down by Mr. Kingzett, he still failed in his purpose. Probably he would have succeeded in the end, but the experiments were interrupted by his leaving my laboratory for a practical situation. As I learned about that time from Mr. Watson Smith that Mr. Frost had been more successful, and as the matter did not seem to possess sufficient importance to interest another student in it (my own time being only too fully occupied elsewhere), I left it where it stands, viz., that the crystals first obtained by Mr. Kingzett from solutions of bleaching-powder have been repeatedly prepared but apparently not further examined, both by himself and others.—I am, &c.,

George Lunge.

Zürich, September, 1882.

COMMERCIAL ANALYSES.

To the Editor of the Chemical News.

Sir,—I am a large consumer of German muriate of potash. In the great majority of cases in my experience, manufacturers of this product sell upon the basis of "Ulex's analysis"—they invariably paying his fee, and he becoming by the fact, not a neutral arbiter, but a partisan, or "seller's chemist."

As this system involves the further evil that it affords no check upon mistakes which even the most upright analyst may make, I have come to the conclusion that it will be cheaper for me in the end to pay for an analysis of my own, and to stipulate in all future purchases of the article that Dr. Tatlock, our well-known authority on the estimation of potash salts, shall act for me and settle the percentage with Dr. Ulex, the analyst for the seller, after the method that has for time immemorial been practised in the case of copper ores. I think other consumers would do well to adopt this course.—I am, &c.,

One.

CHEMISTRY IN GERMANY.

To the Editor of the Chemical News.

Sir,—Having returned from Germany, I observe a slight but important error in my letter (p. 112) sent you from that country. Professor Kekulé told me that the chemical course at Bonn University was chiefly organic, *not* "inorganic."—I am, &c.,

W. A. Ross.

A NEW PROCESS FOR INSULATING ELECTRIC WIRES.

To the Editor of the Chemical News.

Sir,—With reference to the notice under the above heading at p. 122 of your last issue, will you permit me to point out that in January last, in a letter published in the *English Mechanic* of the 20th of that month, I suggested the use of asbestos as a coating for electric wires.

As a mere electrical insulator, the greater cost of, and difficulty of working, asbestos will probably prevent its ever successfully competing with gutta-percha; but as a further coating to the gutta-percha wire (or even, perhaps, as a coating to the naked wire itself), where the wire is exposed to the risk of contact with flame, asbestos probably has a useful sphere of action.—I am, &c.,

Alfred W. Soward.

5, Serjeant's Inn, E.C.,
Sept. 18th, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 8, August 21, 1882.

Appearance of Manganese on the Surface of Rocks. M. Boussingault.—In this very discursive paper the author notes the presence of manganese in the sea and in marine vegetation. He then gives a summary of the *Challenger* expedition, referring, indeed, to the presence of manganese in submarine deposits of volcanic origin, whence he passes on to the thermal stratification of the ocean. He then considers the proportion of carbonic acid in natural waters, including those from great altitudes. This carbonic acid dissolves the iron and manganese carbonates, and on exposure to air re-deposits them as peroxides.

Expansion of the Spectral Rays of Hydrogen.—D. van Monckhoven.—The author in agreement with Mr. Norman Lockyer and in opposition to Secchi, finds that the broadening of the hydrogen rays is absolutely independent of temperature, and is due only to pressure.

Hydrodynamic Experiments: Imitation by means of Liquid and Gaseous Currents of the Stratifications of the Electric Light in Rarefied Gases and of various Forms of the Electric Spark.—C. Decharme.—The author produces an imitation of the stratifications of the electric light by carrying horizontally and quickly over a plate covered with red lead, a tube from which water flows or is blown. The current thus projected forms a straight or curved line over the powdery surface. By varying the conditions of the experiment there are found among the designs obtained forms analogous to those of the stratifications of the electric light in rarefied gases.

Remarks on M. Tommasi's Communication on the Numerical Relations between Thermic Data.—F. le Blanc.—According to M. Andrews (*Annales de Chemie et de Physique*, 1845, vol. xiv., p. 70), when a base displaces another base in its neutral combinations, the heat liberated and absorbed is always the same whatever may be the acid element. MM. Favre and Silbermann have found (*Annales de Chemie et de Physique*, xxxvii., p. 486, 1853) that the heat liberated is sensibly the same when one metal replaces another whatever may be the compound of which it forms part. These two propositions spring the one from the other, and it is merely necessary to add to the heat brought into play in the substitution of the metals the difference of their heat of oxidation, in order to pass from the relation of Favre and Silbermann to that of Andrews. The two former physicists have shown, thirty years ago, the constant differences of the metals and the non-metals. If it has been since found that these relations do not apply to the salts formed by feeble acids, the cyanides, &c.; they nevertheless retain, in the majority of cases, a character sufficiently approximate, very interesting and very practical.

Journal für Praktische Chemie.
New Series. Vol. xxv., Nos. 9 and 10.

Preparation and Correction of Burettes.—Dr. W. Ostwald.—The author states that he has never yet met with a burette free from error, and figures an instrument for quickly effecting the necessary correction.

Sequel to a Memoir on the Cholesterines.—E. Schulze.—A supplement to a paper which appeared in this volume, p. 159. The author maintains that ordinary cholesterine and isocholesterine are definite compounds.

Crystalline Compounds of Phenol with Sulphurous Acid and with Carbonic Acid.—H. Kolbe.—An introduction to the two following papers.

A Compound of Sulphurous Anhydride and Phenol.—Lothar Meyer.—The compound was obtained by Dr. A. Hölzer (Prof. Meyer's assistant) in the winter of 1880-81, on heating dry sodium phenol in sulphurous acid, and afterwards by passing sulphurous gas into dry phenol. Owing to the instability of the compound its formula is doubtful. [A similar compound was patented by Mr. Crookes as a disinfecting agent as far back as 1872.]

An Unstable Compound of Phenol and Carbonic Acid.—A. Klepl.—Salicylic acid, para-oxy-benzoic acid, or a mixture of both, if heated for two hours to 250° to 260° in a hermetically closed tube, is entirely resolved into phenol and carbonic acid. On cooling, the contents of the tube congeal in crystals, which, if gently heated, are decomposed, yielding carbonic acid and phenol.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 6.

Hygienic Signification of Drinking-Water and on Rational Principles for its Examination.—Dr. Max Barth.—The author considers that standards permissible for different substances according to the Vienna Commission on Water Supply, the Rivers' Pollution Commission, &c., are not calculated to throw light on the suitableness of a water for drinking. He examines the questions whether, and under what circumstances, can the water-supply serve as an agent for the propagation of infectious diseases, and what influence has the water-supply upon general health and on the maintenance of the maximum power of resistance against other than infectious diseases? He answers the first question in the affirmative, with especial reference to such disease-germs as are either derived from the ground or undergo there a development before they can produce disease. Such disease-germs he thinks always due to the penetration of matter from sewers and cesspools. Even abstracting from the communication of specific infectious diseases, a water must be considered unwholesome if it is either the seat of putrefaction or contains the constituents necessary to make it such. The more a water approaches the composition of a "culture-solution," the more it must be regarded as suspicious. For most waters microscopical and chemical examinations should go hand in hand.

Use of Carnallite as a Manure and for the Fixation of Ammonia.—Dr. J. Fittbogen.—Carnallite, as well as kainite, gypsum, and "waste salt," were effective in fixing the ammonia of urine. Carnallite in one instance absorbed 97·6 of the total nitrogen present in the food of the animals.

MISCELLANEOUS.

Manurial Experiments at Plan.—L. Koch.—Peruvian guano rendered soluble was tried on barley and potatoes. The smallest quantities of guano produced a visible increase in potatoes, but large doses were required to produce an effect on barley.—*Biedermann's Centralblatt.*

Adepsine.—Our attention has been drawn to a new fatty matter of mineral origin, which promises to become a formidable rival to vaseline. From a document which has reached us—written in rather questionable English—we learn that adepsine is manufactured from petroleum under the superintendence of no less eminent a chemist than Professor Fresenius. It is sent out in three forms, as yellow and white solids, and as a colourless oil of great transparency. All these preparations are free from acidity, and not susceptible of becoming oxidised or resinified by the action of the air. Hence adepsine has probably a great future in prospect for pharmaceutical and cosmetic purposes.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Rancid Butter.—Will you let me enquire the best method to treat rancid butter, and make it saleable, as much of the pure butter imported into England does not keep good more than a month or so, and when it turns rancid it has to be sold at a great loss?—W. Criper.

Precipitation of Copper by Electrolysis.—Will you inform me whether the acid from which the copper is precipitated by electricity at Ocker, in Germany, or at Birmingham, is sulphuric acid or not, and I would also like to know is the acid decomposed so that after the copper is precipitated it cannot be used again as a solvent for, say, carbonates of copper.—J. T.

CITY AND GUILDS OF LONDON INSTITUTE,
TECHNICAL COLLEGE, FINSBURY.

The New Building will be open in January, 1883. During the winter term, commencing Monday, October 9th, Professors Armstrong and Ayrton will continue their instruction in TECHNICAL CHEMISTRY and ELECTRICAL ENGINEERING. Professor Perry will commence a course of Lectures and Laboratory Instruction in MECHANICAL ENGINEERING, and Mr. A. F. Brophy will hold classes in DRAWING, PAINTING, Design, &c., and will commence a course of Lectures on ART FURNITURE and Fittings.—For prospectus apply at the temporary class rooms of the Inttitute, Cowper Street, E.C., or at the Central Office, Gresham College, E.C.

PHILIP MAGNUS, Director and Secretary.

OWENS COLLEGE, VICTORIA UNIVERSITY (MANCHESTER).—SESSION 1882-3.

1. DEPARTMENT OF ARTS AND LAW.

2. DEPARTMENT OF SCIENCE AND ENGINEERING.

The SESSION will open in these Departments on TUESDAY, October 3. Students will be admitted on and after WEDNESDAY, September 27. Candidates for admission must not be under Fourteen Years of Age, and those under Sixteen will be required to pass an Entrance Examination in English, Arithmetic, and Elementary Latin, to be held on SEPTEMBER 29.

3. DEPARTMENT OF MEDICINE AND SURGERY.

The SESSION will open on MONDAY, October 2. Students are required before entering to have passed one of the Preliminary Examinations prescribed by the General Medical Council.

4. EVENING CLASSES.

The SESSION will open on MONDAY, October 9. New Students will be admitted on WEDNESDAY, THURSDAY, and FRIDAY preceding, between half-past 6 o'clock and 9 o'clock P.M.

Several ENTRANCE EXHIBITIONS are offered for competition at the beginning of the Session in Classics, Greek Testament, Mathematics, English, and History; and also a Dauntesey Medical Scholarship, value £100.

Prospectuses of the several Departments may be obtained at Mr. Cornish's, Piccadilly, and at other Booksellers' in Manchester, and they will be forwarded from the College on application.

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The NEXT SESSION will commence on TUESDAY, the 3rd of OCTOBER, 1882.

The Calendar, containing full information as to the Classes, Fees, &c., is now published by Cornish Brothers, New Street, Birmingham, Price 2s., by post 2s. 4d.

GEO. H. MORLEY, Secretary.

UNIVERSITY COLLEGE, BRISTOL.

Professor—W. RAMSAY, Ph.D.
Lecturer—SYDNEY YOUNG, B.Sc.

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THE CHEMICAL NEWS.

Vol. XLVI. No. 1193.

THE INFLUENCE OF AQUEOUS VAPOUR ON THE EXPLOSION OF CARBONIC OXIDE AND OXYGEN.*

By HAROLD B. DIXON, M.A.,
Millard Lecturer in Chemistry, Balliol and Trinity Colleges, Oxford.

Two years ago I had the honour of showing before the Chemical Section of the British Association some experiments, in which a well-dried mixture of carbonic oxide and oxygen was submitted to electric sparks without exploding.† It was further shown that the introduction of a very minute quantity of aqueous vapour into the non-explosive mixture was sufficient to cause explosive combination between the gases when the spark was passed. The hypothesis advanced to account for the observed facts was that carbonic oxide does not unite directly with oxygen at a high temperature, but only indirectly through the intervention of water-vapour present, a molecule of water being decomposed by one of carbonic oxide to form a molecule of carbonic acid and one of free hydrogen, and the latter uniting with the oxygen to re-form a molecule of water, which again undergoes the same cycle of changes, till all the oxygen is transferred to the carbonic oxide :—

$$H_2O + CO = H_2 + CO_2$$
$$H_2 + O = H_2O$$

For such a series of reactions a *comparatively* few molecules of water would suffice, and the change produced by their alternate reduction and oxidation would come under the old term of "catalytic action," inasmuch as the few water molecules present at the beginning are found in the same state at the completion of the reaction.

The truth of this hypothesis has since been confirmed by experiments I have made on the incomplete combustion of mixtures of carbonic oxide and hydrogen, and on the velocity of explosion of carbonic oxide and oxygen with varying proportions of aqueous vapour. I therefore thought a description of the more convenient methods lately devised as lecture experiments for showing the influence of water on the combustion of carbonic oxide would not be uninteresting to the Section.

A glass tube from 18 inches to 2 feet long, closed at one end, and provided with platinum wires, is bent near its open end so that the shorter arm makes an angle of about 60° with the longer arm. The tube, held by a clamp, is heated in a Bunsen flame, and is then filled with mercury heated to about 130° C. The mixture of gases is then made to displace a portion of the mercury by forcing it through a fine tube, which is connected by a steel cap to the eudiometer of McLeod's gas apparatus, and passes down through the mercury in the shorter arm of the experimental tube. When a sufficient quantity of the gaseous mixture has been collected in the longer arm, some dry phosphoric oxide is introduced in the following way :—A small glass tube is heated, packed with the dry powder, and pushed down into the shorter arm of the experimental tube. With a hot glass rod the phosphoric oxide is pushed out at the bottom of the small tube, and passes up into the gaseous mixture in the longer arm. After standing for a few hours in contact with the phosphoric oxide, the gases may be submitted to strong sparks from a Leyden jar without igniting. Care must be taken that none of the oxide comes in contact with the platinum wires, for if any sticks to the wires it becomes heated by the passage of the sparks, and gives off enough water to determine the explosion. In this way I have prepared several specimens of a non-explosive mixture of carbonic oxide and oxygen in the proper proportions to form carbonic acid. Some of these tubes have been submitted without explosion to sparks from a large Leyden jar, to a continuous succession of sparks from a Holtz machine, and to the discharge of a Ruhmkorff's coil, that heated the platinum wires between which it passed to bright redness. Other tubes which withstood the passage of the sparks from a Leyden jar, when submitted to the discharge of the coil, exploded after a few seconds when the platinum wires became red-hot. This I think may probably be attributed to hydrogen, occluded by the platinum, being given off on heating, and forming steam with the oxygen present.

For an easy and striking lecture experiment, I employ a tube open at both ends and bent like a W. The two open arms are short and the platinum wires are fixed at the highest bend. The tube is filled with hot mercury—one of the ends being closed by a caoutchouc stopper for the purpose—and a dry mixture of 5 volumes of air and 2 volumes of carbonic oxide is introduced into the bent tube over the mercury. A little phosphoric oxide is passed up one arm. After a few minutes the gases may be submitted to the spark without exploding. A little water may then be introduced through a pipette into the other arm, and if the spark is passed directly the gases ignite in the wet and not in the dry arm of the tube.

The admixture of the inert nitrogen renders a larger quantity of aqueous vapour necessary for the explosion than when only carbonic oxide and oxygen in proper proportion are present.

* Read before the British Association, Southampton Meeting, Section B, 1882.

† "Report of British Association," 1880, p. 503.

THE VELOCITY OF EXPLOSION OF A MIXTURE OF CARBONIC OXIDE AND OXYGEN WITH VARYING QUANTITIES OF AQUEOUS VAPOUR.*

By HAROLD B. DIXON M.A.

I have endeavoured to compare the velocities of explosion of mixtures of carbonic oxide and oxygen with varying quantities of aqueous vapour by observing the pressure registered in a mercurial gauge attached to the eudiometer in which the gases were fired. In each experiment the same mass of carbonic oxide and oxygen was exploded at nearly constant temperature and volume. The gauge (of 1 m.m. bore) was U-shaped, and contained air in the closed limb. An index, similar to those used in Six's thermometer, was carried up and left at the highest position reached by the mercury. Near the bend of the gauge two bulbs were blown in the tube, as reservoirs, enabling the mercury to be lowered in the eudiometer without permitting the air to escape from the closed limb of the gauge.

Since the total quantity of heat evolved in each explosion was the same, and the cooling surface was the same in each experiment, a quicker explosion would bring the column of gases to a higher average temperature than a slower explosion, and would consequently cause a sharper push on the mercury column. If a sufficiently sensitive gauge were attached to the eudiometer its readings would give comparative indications of the rate of explosion of the carbonic oxide and oxygen. The gauge employed was found to be not very sensitive, but the difference between its readings, (1) with the slow combustion of the nearly dr gases, and (2) with the rapid explosion of the saturated gases, was well marked.

In two experiments a trace only of aqueous vapour was

* Read before the British Association, Southampton Meeting, Section B, 1882.

present. The eudiometer was dried at 80° C. by drawing through it for half-an-hour air which had passed through two long sulphuric acid drying tubes and a small tube containing phosphoric oxide. It was found that by this method of drying, just sufficient aqueous vapour remained in the tube to enable the combustion to take place slowly when sparks from a Ruhmkorff's coil were passed through the gases. In the first experiment several sparks were passed before the gases took fire. In both experiments the flame took about two seconds in passing down the length of 500 m.m. occupied by the gases in the eudiometer. In three other experiments measured quantities of aqueous vapour were added, the vapour being kept below the saturation-point; in the last two experiments the space was saturated with aqueous vapour, and the sides of the eudiometer were wet.

The following table gives the quantities of aqueous vapour in each experiment, the readings of the pressure gauge, and the pressures corresponding to those readings:—

TABLE.

Explosion of Carbonic Oxide and Oxygen with Varying Quantities of Aqueous Vapour.

	Tension of Carbonic Oxide and Oxygen.	Tension of Aqueous Vapour.	Reading of Pressure-gauge before Explosion.	Reading of Pressure-gauge after Explosion.	Pressure Registered in Gauge.	Temperature of Gases.	Length of Column.
	M.m.	M.m.			M.m.		M m.
1.	200	trace	229	236	562	33° C.	500
2.	,,	trace	,,	236·2	563	33·2	500
3.	,,	8·7	,,	249·2	620	33	505
4.	,,	9·4	,,	249·6	622	33·5	505
5.	,,	25	,,	249·4	621	34	514
6.	,,	38	,,	252·6	638	33·3	524
7.	,,	40	,,	252·6	638	34	525

Before each explosion the mercury in the gauge was brought to the mark 229 on the scale, which indicated a pressure of 533 m.m. of mercury on the air in the closed limb.

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Indium.—Indium ferrocyanide being relatively very soluble (especially at 60° to 70°) in a hydrochloric liquid containing from ⅛ to ¼ of the concentrated acid potassium ferrocyanide may be used for extracting moderate quantities of indium mixed with much gallium. Yet gallium ferrocyanide retains sensible traces of indium, and the operation needs to be repeated if we wish to obtain an exact separation. This inconvenience, and that of introducing iron into the analysis, render the process somewhat long and difficult. It is only to be recommended when we wish to separate along with a little indium other metals, such as aliminium and chromium.

Of all the methods tried the following is the only one which effects a prompt and accurate separation. The solution, suitably concentrated, is treated with a slight excess of boiling potassa. The boiling is kept up for some minutes, for in the cold indium oxide is not immediately thrown down by potassa. The precipitate retains merely very slight traces of gallium, which are entirely eliminated by one, or at most two, repetitions of the same treatment. The potassic solutions contain merely slight traces of indium capable of being neglected in weight if the masses of gallium and indium are small, and consequently the volume of the alkaline liquids is moderate. To extract these traces of indium the solution is supersaturated with a very slight excess of hydrochloric acid, and the gallium and indium are precipitated together by slowly boiling the liquid after supersaturation with ammonia, or better still by means of cupric hydrate. The gallium and indium chlorides are transformed into slightly acid sulphates; a quantity of ammonium sulphate is added, slightly larger than what is necessary to transform all the gallium sulphate into alum, and the liquid is then concentrated to a very small volume. After cooling, whether crystals of alum are already formed or not, the solution is mixed with four to five times its volume of alcohol at 70 per cent. The agitation causes the deposit of gallium-ammonium alum in a crystalline powder which is washed once or twice with alcohol at 70 per cent. The alum is then taken up in a little hot water containing a trace of sulphuric acid and the operation is repeated several times. By far the larger quantity of the gallium is in this manner transformed into ammoniacal alum free from indium. The alcoholic solutions containing a small quantity of indium and gallium are concentrated down to a small bulk. The oxides are thrown down by boiling with ammonia, or by means of cupric hydrate; they are dissolved in hydrochloric acid, and are then treated with boiling potassa. We obtain thus a small supplementary quantity of indium free from gallium. As very little potassa suffices the slight traces of indium in the alkaline solution are absolutely unimportant, though the last residue of gallium may be separated as alum if its quantity is noteworthy. Generally the traces of indium carried by the potassa along with the gallium are entirely eliminated after four alcoholic crystallisations of the gallium-ammonium alum. With gallium containing 4 per cent of indium seven or eight re-crystallisations are necessary. These operations are performed very rapidly and easily with the salt derived from less than 0·01 grm. of gallium.

Separation from Cadmium.—This separation is effected in an approximate manner only by means of sulphuretted hydrogen. The difficulty is that in presence of a decided excess of hydrochloric acid the cadmium is not entirely precipitated, whilst if the solution is scarcely acid a portion of the gallium remains in the cadmium sulphide. Nevertheless, good results may be attained by a succession of operations, each of which yields a decreasing quantity of cadmium sulphide free from gallium. For this purpose a decidedly acid solution is treated with sulphuretted hydrogen, the precipitate is re-dissolved with hydrochloric acid, diluted with water, and again treated with sulphuretted hydrogen. This reaction, if repeated once or twice, enables us soon to collect the greater part of the cadmium as a sulphide free from gallium. The liquids which hold in solution all the gallium along with a little cadmium are concentrated to expel the large excess of acid, diluted with water, and saturated with sulphuretted hydrogen. The new deposit of cadmium sulphide obtained is dissolved and re-precipitated once or twice to free it from gallium. The repetition of this treatment frees the gallium chloride from every sensible trace of cadmium.

An excess of boiling potassa precipitates cadmium oxide and dissolves gallium oxide, of which a small quantity remains in the cadmium oxide. It is therefore re-dissolved in hydrochloric acid and separated again by means of potassa. When the cadmium is in a somewhat large proportion four or five treatments are needful to extract all the gallium. The alkaline liquids contain merely feeble traces of cadmium; to separate these the liquid is supersaturated with a very slight excess of hydrochloric acid, and the gallium is removed by means of cupric hydrate. The filtered solution is mixed with a little ammonium acetate and saturated with sulphuretted hydrogen, which precipitates copper and cadmium sulphides. These are taken up in aqua regia, evaporated with an excess of hydrochloric acid to destroy the nitric acid, and this very acid solution is then treated with sulphuretted hydrogen. The copper is thus eliminated, and we have merely to concentrate in order to obtain cadmium chloride.

The four following procedures are more expeditious:—

1. A prolonged boiling after supersaturation with ammonia precipitates gallium and leaves cadmium dissolved, but the original liquid should be very acid in order

to form a sufficient quantity of ammonium chloride. The gallium oxide thus obtained retains very slight traces of cadmium, which are eliminated by a second similar treatment.

2. The separation can be effected well with potassium ferrocyanide, provided that the liquid contains about one-third of its volume of concentrated hydrochloric acid, which holds the cadmium ferrocyanide in solution.

3. Cupric hydrate, with the aid of heat, precipitates gallium containing scarcely a trace of cadmium, which a second operation entirely removes. This is an excellent process.

4. If it is required to remove iron at the same time as cadmium the slightly acid liquid is reduced in heat by metallic copper, and is then mixed with a slight excess of cuprous oxide. The gallium oxide collected contains traces of cadmium which disappear on a repetition of the same treatment. The reactions of cupric hydrate and of metallic copper with cuprous oxide are the most to be recommended of all which the author has studied.—*Comptes Rendus.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING AUGUST 31ST, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

September 1st, 1882.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the month of August, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 182 samples, one was recorded as slightly turbid, and one as very slightly turbid. The remaining 180 samples were found to be bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from August 1st to August 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, one was recorded as "slightly turbid," and one as "very slightly turbid," the remaining 24 samples being found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Grand Junction Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, the whole were found to be well filtered, clear, and bright.

With regard to the general state of the water in respect of its freedom from turbidity, we would draw special attention to the circumstance, that out of the 1074 samples of water examined by us during the six months ending August 31st, and despite the frequent storms of July and August, twenty samples only, or less than 2 per cent, were recorded as "very slightly turbid," and seven samples only, or less than ¾ of a cent., as "slightly turbid."

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

In respect of colour, aëration, and freedom from excess of organic matter, the excellent condition of the water, as noted in our previous reports, has been fully maintained.

We have the honour to remain, Sir,
Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

CHEMICAL LITERATURE.

AN ADDRESS DELIVERED BEFORE THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, AT MONTREAL, AUGUST 23, 1882.

By Prof. H. CARRINGTON BOLTON, Ph.D., Vice-President.

(Continued from p. 148).

PASSING over a period of fifty years, the next complete compendium of chemical knowledge which we notice is the "Elementa Chemiæ" of Hermann Boerhaave, the celebrated professor of botany, chemistry, and medicine in the University of Leyden. Boerhaave's great erudition, purity of style, and brilliant eloquence attracted students in great numbers; such was the popularity of his lectures that "certain booksellers who aimed at lucre by the most scandalous means," published them in 1724, without his authority or consent; this "surreptitious edition"* contained, as Boerhaave himself complains, such "false, ridiculous, and absurd things in every page," that he was compelled to publish his lectures in an accurate and complete form. Both editions were translated into English by Dr. Peter Shaw, and the authorised work passed through many editions in Latin, French, and German.† Instead of attempting to give an analysis of two quarto volumes, we will quote Boerhaave's own account of his plan.

"My design," he says, is to initiate students in the knowledge of chemistry and to do this in the most effectual manner, I shall give a clear methodical explication of all that is necessary for understanding the best authors, and for performing the chief operations in this experimental art." After acknowledging the difficulty of a systematic treatment of "a science which has been cultivated rather by experiments at random than upon any regular principles, and by persons usually destitute of all . . . knowledge in the liberal arts;" he claims that "these obstacles may be surmounted by making a collection of the several effects, which the art has actually pro-

(Works marked (*a*) are in the private library of the author.)

* (*a*) Herrman Boerhaave, "A New Method of Chemistry including the Theory and Practice of that Art." Translated by Peter Shaw and E. Chambers. London, 1727.

† (*a*) Herrman Boerhaave, "A New Method of Chemistry including the History, Theory, and Practice of that Art." Translated by Peter Shaw. London, 1573. [Third Edition.]

duced, justly deducing general rules therefrom, and duly digesting the whole." He then explains the division of his work into three parts.

"The first will rehearse the origin, progress, cultivation, and fortune of chemistry . . . ; the second part will deliver certain theorems or principles of chemistry; the third will exhibit the actual operations of chemistry, whereby bodies are changed agreeably to the rules of the art and to the end proposed therein." Boerhaave's sketch of the history of chemistry begins with the earliest times, but seems to have been left incomplete; it is rendered useful by classified lists of chemical writings and numerous references.

In his treatment of the theory he departs somewhat from his plan and introduces material which really belongs to the third or practical part. Boerhaave introduces sections on the use of chemistry in natural philosophy, in medicine, and in the mechanical arts; gives an exhaustive account of the wonderful nature of fire, and experiments in heat, together with ingenious speculations concerning the heat of celestial bodies; he describes the various forms of chemical apparatus and the preparation of curious and useful substances from the vegetable, animal, and mineral kingdoms. Boerhaave exhibited the spirit of a true philosopher, and produced a work of extraordinary merit. He was quite free from the follies of alchemy, though he cautiously remarks that "we should always remember the limits of nature are by no means to be defined by us, things are taken for impossible which are only unknown by the ignorant," and "many things in chemistry are apparently more incredible than that lead should lose its natural form and be converted into gold."*

Contemporary with the systematic compilations of Libavius, Le Febvre, Boerhaave, and others, were published hosts of independent works setting forth the results of prodigious labour in the chemical laboratory; many of these are filled with descriptions of experiments made at haphazard, with no definite object in view, and having no necessary connection with each other.

Glauber's† voluminous writings, published in 1658, may be taken as an example of this class; in his works, amid controversies with Galenical physicians and curious apologies resulting therefrom, amid descriptions of alchemical mysteries and receipts for a universal panacea, amid extravagant praises of the "sal mirabile" (Glauber's salt), and curious narratives of personal history, we find many novel chemical facts having a medical or an industrial value. The whole is clothed in a very crude style with an affectation of secrecy and under capricious captions.

On the other hand, some of these treatises show signs of genius, especially in attempts to establish theories in explanation of the familiar yet astonishing phenomena; thus Van Helmont, whose contributions to medical chemistry we pass by, invented the word *gas* to aid in discriminating aëriform bodies;‡ and Rey, in his "Essays on the increase in weight of tin and lead when calcined;"§ demonstrated the weight of the air thirty years before the masterly researches of Boyle.

To attempt in this rapid review to do justice to the philosophical writings of the Hon. Robert Boyle is a hopeless undertaking. From his first publication, in 1660, "New experiments, physico-mechanical, touching the spring of the air and its effects," to his posthumous treatise "Medicinal Experiments," published in 1692, his works teem with ingenious experiments described with great candour and fidelity, and from which conclusions are drawn with cautious reserve and philosophical soundness, as admirable as his rare modesty.

In his "Sceptical Chymist" (London, 1661), Boyle raises doubts as to the elementary nature of earth, air, fire, and water, as well as of the alchemical principles, sulphur, salt, and mercury, and claims that the first elements of bodies are atoms of different shapes and sizes, the union of which forms what are vulgarly called elements; he argues that their number should not be confined to three nor four, but that probably a large number of primary constituents would eventually be separated or isolated as such. He also first clearly recognises the distinction between mixture and chemical combination.

The rejection of Boyle's prophetic hypothesis by his contemporaries much retarded the progress of the science. "More, however, than for his views on the nature of the elements, science is indebted to Boyle for his clear statement of the value of scientific investigations for its own sake, altogether independent of any application for the purposes either of the alchemist or of the physician. . . . Boyle was in fact the first true scientific chemist, and with him we may date the commencement of a new era for our science when the highest aim of chemical research was acknowledged to be the simple advancement of natural knowledge." (Roscoe).

Boyle's voluminous writings were collected by Birch in five folio volumes and published in 1744. His diffuse style of composition, with frequent long digressions, renders a perusal of his writings wearisome, and led to an edition by Dr. Shaw, in which his works are "abridged, methodised, and disposed under general heads," forming three quarto volumes bearing the date 1725.* Many of Boyle's papers were published in the *Philoophical Transactions*.

The literature pertaining to the theory of phlogiston belongs almost wholly to the eighteenth century. It is true that Becher's Physica Subterranea was published in 1659,† but the theory of a combustible principle existing in all metals remained dormant until Becher's admirer, George Ernest Stahl, published an edition of the Physica Subterranea in 1702; to this he prefixed a long preface elaborating those doctrines which exerted such immense influence on both the theoretical and practical science, for more than a century. The writings of Becher and Stahl are notorious for their barbarous mixture of poor Latin and German, for which indeed both authors apologise.‡

In Mayow's Treatise on the nitro-aërial spirit,§ we find records of admirable experiments in pneumatic chemistry supported by accurate reasoning and almost prophetic insight of later theories of combustion, but his early death prevented the continued support of his views, and Mayow's treatise was soon forgotten by the prejudiced followers of Stahl.

In the year 1683 a noteworthy event occurred in the chemical world, the opening of public laboratories of instruction. Chairs of chemistry had long existed in institutions of learning, the first being filled nearly eighty years before by Johann Hartmann, and the honour belonging to the University of Marburg. Practical instruction had been secured also in the private laboratories of the wealthy, thus Homberg and Friedrich Hofmann worked in Boyle's establishment,‖ but the first public laboratory for instruction was opened at Altdorf, Bavaria, under the direction of Prof. J. M. Hofmann. A survey of the status of chemical knowledge at that date offers a tempting digression, but the length of this address forbids.

The second public laboratory was opened in the same year (1683) at Stockholm, under the patronage of Karl XI. of Sweden, and under the guidance of Urban Hiärne. Both institutions issued publications bearing the general title Acta,¶ which may be regarded as forerunners of the

* *Idem*, vol. 1, p. 204.

† (*a*) The works of John Rudolph Glauber, containing great variety of choice secrets in medicine and alchymy . . . Translated into English by Christopher Packe. London, 1689, fol.

‡ *Ortus medicinæ, vel opera et opuscula omnia*, 1648.

§ Jean Rey, *Essais sur la recherche de la cause, pour laquelle l'Estain et le Plomb augmentent de poids quand on les calcine*, Bazas, 1630.

* (*a*) The Philosophical Works of . . . Robert Boyle abridged . . . by Peter Shaw. London, 1725. 3 vols. 4to.

† (*a*) J. J. Becher, *Chymisches Laboratorium oder Unterirdische Naturkundigung*. Francfurt, 1690.

‡ Kopp's *Geschichte*, I., 180 and 192.

§ *Tractatus Quinque medico physici quorum primus agit de sal-nitro et spiritu nitro-aereo* . . . Oxonii, 1674.

‖ Kopp's *Geschichte*, II., 19.

¶ (*a*) *Acta laboratorii Altdorfini*. Altdorf, 1719. Also: *Laboratorium novum chemicum, &c.*, 1683. *Actorum chemicorum Holmensium*.

"Contributions from the Laboratory of —— University," now so common in periodical literature.

Lexicons and dictionaries have been a feature of chemical literature from the earliest times; we have already alluded to the vocabularies of the sacred art found among the Greek MSS. of the Paris National Library, and referred to the tenth and eleventh centuries. These, however, seem to have been compiled for the purpose of misleading the novice in alchemical mysteries, and as Hoefer justly remarks, themselves need commentaries to become intelligible.

The universal employment of symbolic characters, to represent both chemical substances and operations, rendered alchemical literature difficult of perusal and early led to the publication of keys and vocabularies explaining them. Such keys occur in the manuscripts just mentioned, in Eschenreuter's "Universal Panacea for Men and Metals,"* which purports to have been written in or before the fourteenth century, and in the works of Oswald Crollius,† Kircher,‡ Le Febvre, Lemery, and many other authors of the seventeenth century: these, however, are not properly dictionaries.

Dr. Martin Ruland, court physician to Rudolph II., published a "Lexicon alchemiæ" in 1612, and William Johnson§ a "Lexicon chymicum" in 1657, but the first really satisfactory treatment of chemistry in monographs alphabetically arranged was by Macquer,‖ whose "Dictionnaire de Chymie," published in 1766, had great success, passing through several editions, and being translated into the German, English, Italian, Spanish, Danish, and Russian languages.¶ Macquer found many followers, among whom may be mentioned Nicholson (1795), Cadet (1803), and well known authors whose works are indispensable to all students of the science.

Prof. Wm. Ripley Nichols, of Boston, late chairman of this Section, in a recent private communication, has expressed the need of yet another dictionary, one of chemical synonyms. He calls attention to the large number of names by which certain chemical substances have been known at different epochs and in different professions, and to the utility of a dictionary explaining their synonymy. Professor Nichols suggests "restricting the list to terms found in the literature of the preceding hundred years, but including such alchemical names as have peculiar historic interest and such as have persisted more or less in commerce and pharmacy." He also suggests that the work should include English, French, and German names, except when they are simply literal renderings of the same term, and names of those minerals which are of simple composition like halite, witherite, fluorite, &c., under their appropriate heading. In an example of the proposed method of treatment he gives a long list of names for ferric oxide under the several heads: alchemical, chemical, mineralogical, pharmaceutical, commercial, and popular.

The idea is certainly excellent, and we mention it publicly in the hope that Professor Nichols may be incited to compile such a work. We are not aware of the existence of any modern chemical synonymicon, not having seen Berta's Dictionary of chemical terms,** published at Padua in 1842; perhaps the nearest approach to the ideal work of Professor Nichols is Sommerhoff's Lexicon pharmaceutico-chymicum,†† published in 1701, a folio of 400 pages.

About the middle of the seventeenth century the dissemination of the views of Lord Bacon, as expressed in his *Novum Organon*, gave a great impulse to scientific investigations, and the "splendid fiction of the new Atlantis" was practically realised in the foundation of the "Royal Society for Improving Natural Knowledge." The learned men, who in 1645 met in London, and there disturbed by unhappy dissensions of civil war withdrew to Oxford to report and discuss philosophical experiments, laid the foundations of an edifice destined to rise higher, endure longer, and to shelter a nobler offspring than the most sanguine could have foreseen. The organisation was granted a charter by King Charles II. in 1662, and three years later began the publication of the "*Philosophical Transactions*, giving some accompt of the present undertakings, studies, and labours of the ingenious in many considerable parts of the world." In the following year the French Academy of Sciences began their Mémoires. Thus arose the element of periodicity in scientific literature, one which rapidly increased in importance.

The year 1665 also witnessed the birth of the parent of that large class of periodicals not issued by societies, but published by private parties either individually or coöperatively. The first number of the "Journal des Sçavans" appeared January 5, 1665, and for one hundred and thirty years was the most prominent literary and scientific journal of Europe. At that early date the periodicals partook of a literary nature rather than of the scientific, but gradually these two elements became distinct, and the lines became more and more closely drawn until every branch of pure and applied science supported a serial especially devoted to its progress. Among the earliest periodicals devoted to chemistry and its associate physics may be mentioned the "Journal de Physique et de chimie," edited by the Abbé Rozier, de la Méthérie, and others, begun in 1770, and continued through ninety-five volumes to 1822; the "Chemisches Journal" of Lorenz Crell, 1778-86, which was followed by the "Chemische Annalen," by the same editor, extending until 1803. The "Annales de Chimie et de Physique," begun in 1789, enjoys the honour of being the oldest surviving serial of this class.*

Of the foundation of societies exclusively devoted to chemistry in France, England, Germany, and America, and of their periodical publications, we can make mere mention. The existence of a "Columbian Chemical Society" in Philadelphia, as early as 1811, deserves passing notice. Two volumes of its Memoirs were published containing articles by Drs. Mitchell, Cutbush, Manners, Bache, and others.

Of chemical bibliography and works relating exclusively to the history of the science, we have elsewhere† given a critical résumé.

(To be continued).

Black Phosphorus.—P. Thenard.—The author refers to the customary view that black phosphorus is merely a mixture of the ordinary phosphorus with traces of a metallic phosphide, and contends that this explanation is not in all cases admissible. A specimen of black or rather dark grey phosphorus, which the author submitted to the Academy, became white if melted and remained white if suddenly cooled, but if allowed to enter into a state of superfusion it became again black on contact with either white or black phosphorus. A portion of the black specimen being dissolved in carbon disulphide there remained undissolved merely a trace of a very pale yellow matter which seemed to be amorphous phosphorus.—*Comptes Rendus.*

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* (*a*) Basilius Valentinus *Chymische Schriften in drei Theile.* Leipzig, 1769, p. 1050.

† (*a*) *Tractat von den Signaturen*, p. 58, in Crollius's *Basilica Chymica.* Frankfurt, 1647.

‡ (*a*) Athanasius Kircher, *Mundus subterraneus in XII. libros digestus.* Amstelodami, 1665, fol. Part II., p. 322.

§ In Mangetus's *Bibl. chem. curiosa*, I., 217.

‖ P. Jos. Macquer, *Dictionnaire de chymie.* Paris, 1766.

¶ Kopp's *Geschichte*, I., 224.

** Antonio Berta, *Saggio di un dizionario dei termini chimici.* Padova, 1842. 8vo. 32 pp.

†† (*a*) Joh. C. Sommerhoff, *Lexicon pharmaceutico-chymicum latino-germanicum* . . . Norimberg, 1701. Sm. fol.

* The *Journal de chimie et de physique* of Van Mons begun in 1801, and *The Chemist*, edited by M. Mongredieu, in 1824, were short-lived. This is true also of Richter's *Neuere Gegenstände in der Chemie.* 11 nos., 1791-1802.

† H. C. Bolton, "Outlines of a Bibliography of the History of Chemistry," Annals N. Y. Lyc. Nat. Hist. Vol. 10, p. 352 (1873).

NOTICES OF BOOKS.

The Concepts and Theories of Modern Physics. By J. B. Stallo. International Scientific Series. Vol. xlii.

In this volume some of the fundamental theories of modern physics are subjected to a searching analysis, with the object of showing how far these are legitimate, and how far they satisfy the requirements of logic and the conditions of valid hypothesis.

The author has precisely the qualifications for instituting such an enquiry, in being well versed in both logic and physical science, and in having a wide acquaintance with the literature of both; and in his independent habit of thought, which prevents his judgment being enslaved by any school of philosophy.

The book abounds in admirable and interesting discussions of fundamental principles of physical science, of which, in the space of a short review, it is useless to attempt to give an adequate account, although some slight idea may be given of the nature of the author's method of dealing with his subject by selecting one or two examples in illustration. It may safely be said that by students of physics and chemistry this book will be found full of interest, not only for the author's discussions, but also for the copious foot-note references to numerous authorities in philosophy and science, which last are indeed a most important and characteristic feature of the book.

It will be desirable to give some slight idea of the scope of the work by stating the scope of its successive chapters, although space will not allow of detailed criticism of the views which the author seeks to establish, or of those which he disputes.

In Chapter I. he contests the general proposition that all physical action is "mechanical" (p. 23).

In Chapter II. he states the first principles of the mechanical theory of the universe to be (p. 28) (1) that the ultimates of scientific analysis are mass and motion; (2) that these two ultimates are disparate, so that mass is indifferent to motion,—that motion may be transferred from one mass to another: (3) that both mass and motion are constant. To these principles he adds the assumption generally made by physicists and chemists of the molecular and atomic constitution of bodies; which assumption leads (according to the author) to four cardinal propositions of the atomo-mechanical theory, each of which he shows, in Chapters III., IV., V., to be denied by the sciences of chemistry, physics, and astronomy; while in Chapter VI., on the "Conservation of Energy," his purpose is, as he says, to show that the history of the evolution of the scientific concepts embraced in this doctrine is (p. 82) the history of a progressive abandonment of the mechanical proposition that all potential energy is in reality kinetic.

Chapter VII. is devoted to the theory of the atomic constitution of matter; to the arguments adduced in support of it from the "indestructibility of matter," and its supposed impenetrability, and the explanations of both by the theory; from Dalton's laws of combining proportions in chemistry; and from the success of the hypothesis of an atomically constituted light-bearing medium in explaining and predicting phenomena. The author comes to the conclusion that *the atomic theory is of doubtful value, even as a working hypothesis.*

In Chapter VIII. a discussion of the kinetic theory of gases is preceded by a discussion of the views held by eminent modern authorities on logic as to the use and abuse of hypothesis; and the author has the courage—some will say the audacity—to declare as his conclusion that the kinetic hypothesis (p. 1.6) has none of the characteristics of a legitimate physical theory.

Having thus dealt with what he calls the mechanical theory of the phenomena of nature and with some applications of it, the author institutes an inquiry (in Chapter IX.) into the question of the origin of this theory and into its attitude towards the laws of thought and the forms and conditions of its evolution (p. 129). He enumerates in this chapter four cardinal metaphysical errors. To show that the mechanical theory is vitiated by these errors is the object of the author in Chapters X., XI., and XII.

Chapters XIII. and XIV. are devoted to the discussion of transcendental geometry; Chapter XV. to the nebular hypothesis and other cosmological and cosmogenetic speculations; while his general conclusions are summed up in Chapter XVI.

The objections of the author to the "mechanical theory" depend largely on his views with regard to matter, mass, motion, force, space, time, as fundamental concepts of modern physics; some of the most important statements of the author with reference to these will now be given as nearly in his own words as the necessary brevity of this review will allow.

Matter (pp. 149, 150) is an ideal concept, formed by putting aside all the physical attributes of bodies except the one which characterises all bodies as physical objects; this one is known under the two aspects of *mass* and *force*, or of *mass* and *motion*; neither mass, force (p. 162), nor motion is an object of sensible experience, nor can mass be thought of by itself; but the two, mass and force, or mass and motion, are the two inseparable attributes of the concept "matter."

Mass—or *inertia*—has no existence apart from force or motion, and neither force nor motion apart from mass (p. 161), and neither mass nor force (or motion) can be measured (pp. 88, 205) except in terms of the other.

Masses are measured only (p. 88) by the action of forces, and the persistent effect of this action is the simple and accurate expression of what is called the "indestructibility of matter" (see also p. 149).

Bodies exist (p. 163) solely in virtue of their relations; their reality lies in their mutual action. Inert matter (or dead matter) is as unknown to experience as it is inconceivable in thought. A body cannot move itself, for the same reason that it cannot exist in and by itself. The very presence of a body in space and time, as well as its motion, implies interaction with other bodies, and therefore *actio in distans* (see also pp. 65, 145).

Force (p. 167) is not an individual thing or entity . . . it is purely an incident to the conception of the interdependence of moving masses; force is the (cause, or) condition, or group of conditions, upon which change of motion depends, and these conditions are always corresponding motions or changes of motion of the bodies outside of the body in question which are its dynamical correlates. Otherwise expressed, force is a mere inference from the motion itself under the universal conditions of reality . . . .; it has no other existence. Force is (p. 168) a purely conceptual term, and not a distinct reality; force and inertia are conceptual integrants of matter, and neither is in any proper sense a fact (p. 161).

[Modern writers on Physics use the word "force" exclusively in the sense of *vis impressa*; Newton used it in the two senses of *vis inertiæ* and *vis impressa*. In the celebrated scholium to the laws of motion, *vis* is used to include both applications of it. With the result that by the words "*ex ejus vi et velocitate conjunctim*," Newton includes under the third law both the principle of action and reaction, and the principle which foreshadowed the doctrine of the Conservation of Energy.]

When the author says that the concept "matter" involves the inseparable attributes, mass and force, or mass and motion, this statement includes the two aspects of matter involving. the one, mass and configuration, and the other, mass and velocity; and therefore the two forms of energy—potential and kinetic.

The author objects (p. 169) to the statement when a body is said to be endowed with a definite quantity of force, as implying the independent reality of force, and as ignoring the fact that the conception of force depends upon the relation between two terms at least; also to the

assumption that an invariable measure of energy is inherent in every particular body or atom; yet, on page 304, he says that each element or compound embodies a distinct and invariable amount of energy, as well as a distinct and invariable quantity of matter (*i.e.*, mass). It is clear that his objection to the statement with reference to such a misuse of the conception of force, as he quotes on page 169, is backed by argumeuts which do not apply in the case of energy, and that we may therefore look on his statement on page 304 as his opinion in the matter of energy, rather than the statement on page 169.

It will be interesting to see how far the author's account of matt r, inertia, force agrees with corresponding statements of Newton in his "Definitions." especially as the author is apparently of opinion that he is in these respects much at variance with Newton.

On page 39. the author, alluding to the definition of impressed force (Def. 4) given by Newton and to Newton's comments on it, seems to infer that Newton considers mass and motion as disparate, as if mass were indifferent to motion so as to remain the same whether in motion or at rest, and as if motion were transferable from one mass to another. Newton (Def. 1) deduces the "quantity of matter" or mass of a body from the results of accurate experiments with pendulums, *i.e.*, he measures masses (relatively to one another) by reference to force (of gravity) or motion; and the measure of the mass of a body once determined is a constant for that body, in all interactions of it with other bodies, and remains the same whether the body be in motion or at rest. So far, there can be no difference of opinion—notwithstanding the fact that mass cannot be represented in thought (p. 149) apart from all idea of force or motion. The statement of Newton is quoted on this page, that "Impressed force consists in action alone and does not abide in the body after action" (Def. 4). The author objects here not to the accuracy of this statement, but to the point of view, which seems to him to suggest a separation of the "conceptual integrants of matter," mass and motion, as if these were disparate, rather than the fusion of the two, which is more consonant with the true relations of these concepts (p. 150), and which fusion is satisfactorily effected by the scientific concepts, potential and kinetic energies.

But the author seems a little too ready to leap to the conclusion that Newton's statements are at variance with a correct appreciation of a true logical view of the terms mass, force, &c. From the author's own standpoint, change of motion (p. 167) of a body depends upon motion or change of motion of bodies (its dynamical correlates) external to the body, and therefore consists only in the action of these bodies in motion, and does not abide in the body in the absence of such external conditions, or after, that is on the removal of, these. Newton says the body, after the action, perseveres in its *new state* by *vis inertiæ* alone; by this phrase showing that the body is not indifferent to motion, although the mass (or *vis inertiæ*) is unaffected. The mass, in fact, has remained the same, while the body has acquired a new state.

On page 162 the author says that Newton expressly speaks of inertia as of a force; this is a confusion of ideas, which Newton carefully avoids, for in his remarks on Def. 3 he carefully distinguishes the passive and active aspects of matter. He says the *vis insita* (the active aspect) does not differ from the inertia of the mass (the passive aspect) except *in the mode of conceiving it*, and from the context, in which he says "this *vis insita* may be called by the very significant name *vis inertiæ*," it is evident that here Newton fuses the two inseparable attributes of matter, viz., force and inertia (p. 161), instead of confusing them.

In Chapter XII., the phrases "absolute time," "absolute space," &c., are shown to be unmeaning collocations of words, expressing nothing knowable or conceivable. The key to the attack on these pseudo-concepts is found in the opening sentence of the Chapter: "The reality of all things which are, or can be, objects of cognition is founded on, or, rather, consists in, their mutual relations" (p. 183). On page 185 the following notable remark will be found: "The law of causality, the conservation of energy, and the indestructibility of matter, so-called, have their root in the relativity of all objective reality—being, indeed, simply different aspects of this relativity, and Newton's first and third laws of motion, &c., are but corollaries from the same principle."

Space is, according to the author (p. 235) a concept, a product of abstraction; an abstract or concept (p. 236); reached by a series of abstractions from the concepts of spatially extended forms, which concepts, in their turn, are the last result of the process of abstracting from objects their different and variable qualities attested by sensation (p. 235). Space has no properties, for, considered as an entity, it has no relations, its very essence being a denial of, or abstraction from, all relations (p. 240). The whole science of geometry is conversant about that which the concept "space" of necessity excludes, viz., about determinations or limits (p. 241).

Again, the author says: "In every act of primary cognition, the objective phenomenon, so-called, and its subjective counterpart, are born (p. 235) into consciousness at the same moment, because the reality of either depends upon that of the other. This is the great primary and irreducible fact of cognition . . . ." This is in answer to (p. 234) the Kantian argument that space must be a subjective form of intuition because the mind cannot banish it from consciousness. Space, not being an object of sensation, cannot be even thought of without bringing into thought with it some object of sensation (p. 233); not being an object of sensation it cannot have diversities among its constituent parts (p. 232), by which diversities matter is distinguished from space. [Here the author uses the word matter, rather inconsistently, in the sense of all bodies, instead of in the sense (pp. 149, 150) implying the concept inclusive of vis and inertia, and exclusive of all other physical attributes.]

Of *Time* the author says (p. 205): "The constancy of the efflux of time, like that of the spatial positions which serve as the basis for our determination of the rates and amounts of physical motion, is purely conceptual." The paragraph immediately following this sentence, which deals with the relativity of *mass*, is very misleading; the last sentence especially, from which the inference might be drawn that equal quantities of ice and liquid water might in some sense be considered to have different masses. For a clear statement respecting mass and its measurement the reader should consult "Maxwell's Matter and Motion," Art. xlvi.

The principle of the Dissipation of Energy—as applied at least to our planetary system—is accepted by the author (p. 272). And with regard to this, as well as to the Conservation of Energy, he agrees that each of the two principles applies only to conservative systems. Now the Infinite Universe is not a conservative system, and therefore these principles do not apply to it (p. 276).

Perhaps there are liberal systems which somewhere are reversing, or sometime will reverse, the dissipating action of conservative systems. But this is a question of cosmic politics, on which the author is silent.

If the atomic theory and the kinetic theory of gases are to be suppressed, as the author intimates in Chapters VII and VIII., "modern" chemistry will disappear with them, or be so changed in outward appearance as to be unrecognisable.

P. T. MAIN.

A Treatise on the Distillation of Coal Tar and Ammoniacal Liquor and the Separation from them of Valuable Products. By GEORGE LUNGE, Ph.D., F.C.S., Professor of Technical Chemistry in the Federal Polytechnic School, Zurich. London: John Van Voorst.

WE have here a valuable and much needed monograph on an important and increasing branch of the chemical arts

The author, who has earned golden opinions in all industrial countries by his great work on the alkali manufacture, is here also practically at home, and though he has carefully collated the literature of the subject, he does not figure as a mere compiler. In addition to former experience, he has carefully inspected, as he tells us, "a series of the largest and best tar and ammonia works in England, France, and Germany. He also acknowledges valuable services rendered him by Mr. Watson Smith and Dr. C. Meymott Tidy. The former of these gentlemen is well known as having been formerly Prof. Lünge's assistant at the Polytechnic School of Zurich.

The author's point of view must be rightly understood in the outset. His object is to explain the processes for separating out on a large scale the useful products pre-existing in coal-tar. With their subsequent transformations and the wonderful compounds to which they give rise, he does not concern himself. In this respect he proceeds on the same principle, *e.g.*, as a metallurgist, who, whilst describing the processes for separating and refining the metals occurring in a complex ore, does not discuss their ultimate applications.

The work opens with an account of the origin of coal-tar and with a history of its successive utilisations. Attention is called to the four great classes of products obtained from the destructive distillation of organic substances; to wit, permanent gases, watery liquids, oily or tarry liquids, and solid residues, such as coke and charcoal. The gases and the solids are less modified by the nature of the body acted on than are the liquid products. The tarry products, especially, are found to vary not merely with the material, but with the temperature employed, and even with the shape and size of the retorts. Hence springs the extreme complexity of tars, the want of uniformity even in coal-tars from different sources, and the difficulty of effecting anything like a perfect separation. We cannot by any means assume that all the bodies present in coal-tar, especially the neutral and indifferent hydrocarbons, have even been detected. The historical survey of the attempts at utilising coal-tar products introduces a mention of certain facts not agreeable either to our national pride or our national pocket. We have substantially lost the manufacture of the coal-tar colours, and our home market is to no small extent supplied by Germany and Switzerland. We also come upon the suggestion that under quite conceivable circumstances it may be more remunerative to treat tar and ammonia as the main products obtainable from the distillation of coal, ranking the gases evolved as a secondary result, and thus inverting the present system. The yield of the liquid products from different kinds of coal varies greatly both in quantity and quality. Thus, whilst English coals yield on an average 4·5 per cent of tar and 6 of ammoniacal liquor, Silesian coal gives 5 to 6 of tar and 9 per cent of ammoniacal liquor.

The author points out a fact little known outside the trade, viz., that the admixture of rich bituminous shales with the coal used at gas works, while it greatly improves the quality of the gas, as greatly injures the tar-products. In such cases the benzol is contaminated with hydrocarbons resembling the so-called light petroleum spirit, which is utterly useless in the colour manufacture. The anthracen is in like manner mixed with paraffin. Neither of these impurities can be eliminated by the methods of fractional distillation or crystallisation. Hence, as Dr. Lünge remarks, tar distillers often stipulate that not more than 5 per cent of oil shales, &c., must be mixed with the coal. The tar from the Boghead mineral (of Torbane Hill, now exhausted) contains toluene and naphthalene, which latter seems to accompany paraffin, but little benzol and anthracen. It appears that the coal-tar of the Scotch gas works has deteriorated with the increased temperatures employed. Twenty years ago when low heats were used the yield of benzene and its homologues was as much as 8 per cent, whilst with increasing heat it had a few years ago fallen to 3 per cent.

The recovery of the volatile products given off, and at present generally wasted in the coke ovens, is also discussed. Here it appears there is still ample room for inventive ability. Experiments in this direction are checked by the common notion, possibly a mere prejudice, that any attempt at condensing the tar, ammonia, and gas must injure the quality of the coke. It is certainly true that the coke of the gas works or retort coke, as it is called, is for metallurgical purposes much inferior to oven coke, but it by no means follows that every method of condensing the gases and vapours must interfere with the production of a compact coke. The process of Knab, as worked at St. Etienne, is said to have given 70 per cent of coke, 4 of tar, 9 of ammoniacal liquor, and 10 of gas, which last product aided in heating the ovens.

A modification of the Knab process is or has been in operation at Bessèges. According to Dr. Angus Smith (Alkali Acts, 14th and 15th Annual Reports for 1877 and 1878), each oven yielded from 9·3 to 10·6 tons of tar, and from 1·59 to 2·13 tons of ammonium sulphate yearly for 390 to 405 tons coke.

The author gives, on the authority of M. A. Hüssener, of Essen, somewhat different results. At Bessèges the products per 389 tons coke were annually 12·89 tons tar, and 6·22 tons ammonium sulphate. These results showed an annual net profit of 1114 francs per annum, not taking the coke into account. The yield of coke is 70 per cent calculated on the coal burnt, but only 60 per cent is described as being of the dense quality for blast-furnaces, the residue being half burnt and porous. The quality of the tar obtained is another serious consideration. Oven tar, according to the comparative experiments of Behrens, is poorer in benzene and toluene, and also in naphthalene, than is retort-tar. It contains more acids, but true phenol is almost wanting. Hence this problem, which may be pronounced of national importance, both from an economical and a sanitary point of view, is not yet solved.

A brief mention is made of the suggested preparation of aromatic hydrocarbons by the decomposition of fatty compounds boiling at high temperatures, that is the heaviest oils of the petroleum and paraffin refineries. Experiments in this direction have given promising results. Thus Letny, by passing petroleum "tailings" from Baku through red-hot tubes, obtained a product rich in benzene, toluene, xylene, naphthalene, and anthracen. According to Rudnew the tar from the manufacture of petroleum gas at the Kasan works is already distilled on a commercial scale, and yields from 10 to 12 per cent of benzol, and about 5 per cent of naphthalene, as well as anthracen, which is capable of being recovered. There is a mere trace of phenols. It is, perhaps, premature to give an opinion as to the future of this process. No one will deny that it would be a great advantage to the makers of artificial colours if they could at any time buy their raw materials in an open market without being under the necessity of contracting.

In the succeeding chapters of the work, Dr. Lünge treats thoroughly and fully of the properties of coal-tar and of its constituents, of its applications without distillation, of the first distillation of coal-tar, of pitch, anthracen oil, creosote oil, carbolic acid and naphthalene, of light oil and the first runnings, of rectification by steam, and of the final products. The last chapter is devoted to the manufacture of liquid ammonia. All these chapters are admirably illustrated with cuts of plant and apparatus drawn to scale whenever this feature is of importance. The processes for testing the various products so as to determine their purity and value form an important feature. This is particularly the case with anthracen. The author gives an account and an appreciation of the alcohol and the carbon disulphide tests, of Luck's method with its latest improvements, besides a process for the estimation of anthracen in tar. The appendix contains a notice of Mr. Allen's process for the determination of paraffin in anthracen, and of Mr. B. Nickels's process—

taken from Mr. Allen's "Commercial Organic Analysis," for testing anthracens.

Dr. Lünge's work does not owe its high value to the mere fact of its being without a rival. It is an admirable specimen of what an industrial monograph should be, giving us theory and practice in harmonious combination.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 9, August 28, 1882.

Dip of the Magnetic Needle.—M. d'Abbadie.—A description of a dipping-needle made by MM. Brunner.

Separation of Gallium.—Lecoq de Boisbaudran.—See page 152.

Formation of Secondary Elements of Lead Plates.—G. Planté.—The author augments the capacity of accumulation by producing a preliminary deposit of lead on the electrodes. He effects this by means of a series of changes of the direction of the primary current with intervals of rest between.

No. 10, September 4, 1882.

Distribution of Heat in the Dark Regions of the Solar Spectrum.—P. Dessains.—Not suitable for abstraction.

Typhoid Fever at Paris from 1875 to 1882.—M. de Pietra Santa.—For some years typhoid fever has assumed in Paris more alarming proportions. The deaths from this cause, which in 1865 were 1·90 per cent of the total mortality, have during the first half of the present year risen to 4·60 per cent. The mortality is greatest in the months of April and November; the distribution of the disease in the various districts of the city follows no general law, and bears no direct proportion to density of population and general mortality.

Theoretical and Practical Considerations on the Phenomena of Electromagnetic Induction. Application to the most Abundant Types of Machines.—G. Le Goarant de Tromelin.—A mathematical paper, not adapted for useful abstraction.

Law of the Thermic Constants of Substitution.—D. Tommasi.—The author gives examples in reply to the objection that his law is inapplicable when it is required to calculate the calories of combination of soluble salts formed by weak acids.

Certain Compounds belonging to the Group of the Creatinines.—E. Duvilliers.—The author gives an account of methyl-amido-*a*-butyro-cyamidine or creatine-*a*-butyric, and of methyl-amido-iso-valero-cyamidine, or iso-valeric creatinine.

No. 11, September 11, 1882.

This issue contains no chemical matter.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xi., Part 6.

Influence of Cultivation of Crops in Forests on the Nature of the Soil.—Dr. Hanamann.—The author shows that such cultivation must ultimately impoverish the soil, especially in phosphoric acid.

Potassium Salts as Manure for Beetroot.—Prof. Maercker.—In moist seasons potassium chloride has no special effect; in dry seasons it increases the crop by 20 to 30 cwt. per morgen.

Manurial Experiments at Königsberg.—Dr. Klien.—In general superphosphate was more effective than precipitated.

Digestive Secretions of the Horse.—MM. Ellenberger and Hofmeister.—In the saliva of the maxillary gland there is present pytaline, a ferment capable of converting starch into sugar. In the saliva of the parotid gland there is a peptonising ferment, but in very small quantity. The mixed saliva emulsifies fats, but does not decompose them. The saliva of the horse does not dissolve cellulose.

Causes of Tuberculosis.—MM. Koch, Baumgarten, and Toussaint.—Tuberculosis is considered as a parasitic disease.

Application of the Aræometric Determination of Fat to Poor Milk.—Prof. F. Soxhlet.—In poor milks the ethereal solution of fatty matter is caused to separate by the addition of a very small quantity of potassium stearate; the oleate has no action.

Liberation of Gaseous Nitrogen in Putrefaction.—Dr. B. E. Dietzell.—The author finds, in opposition to Hufner, and in accordance with Reiset, Lawes, Gilbert, and Pugh that during the putrefaction of nitrogenous matter nitrogen escapes in the free condition. The author traces its origin to nitrous acid, which is formed in the earlier stages of putrefaction, and which evolves free nitrogen by its action upon leucine, the primary amines, and ammoniacal salts. To prevent this reaction he recommends the addition of lime.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., June, 1882.

This issue contains no chemical matter.

July, 1882.

This number contains no chemical matter save the well-known discourse delivered by M. Dumas on presenting M. Pasteur with the commemorative medal, and a popular lecture on the colouring-matters and other products of coal, by M. E. Grimaux. [We regret to find that here Philippi Lebon is put forward as the original inventor of coal-gas as a source of heat and light, though the idea had been brought forward ten years previously by W. Murdoch]

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. 13, No. 15.

Separation and Determination of Arsenic.—Emil Fischer.

Atomic Weight of Glucinum.—Lothar Meyer.—The author considers our knowledge of relations between the atomic weights of the elements far too incomplete to warrant us in correcting the results of observations. He has already cautioned against the tendency to increase regularities by any manipulation of the stœchiometric figures as experimentally determined. He considers it theoretically possible that a member of one family may have a higher atomic weight than the corresponding member of the following family, though the atomic weights of the latter are on the average higher. We do not yet understand the causal connection between the differences of the atomic weights and the variations of properties. Differences of weight may occur which do not occasion any general change of properties, as on the other hand equality in atomic weights may be attended by a difference in properties, as in case of nickel and cobalt. Hitherto every atomic weight which at first could not be correctly inserted in the periodic series has been so corrected by repeated observations as to take its true place. This holds good with about the fourth or fifth part of the elements. Doubt prevails merely in the case of tellurium. As the result of his experiments, the author considers glucinum bivalent with the atomic weight 9·10.

A New Kind of Tetra-hedrite.—F. W. Clarke and Mary E. Owens.—The authors have examined a variety of tetra-hedrite, in which a part of the copper is substituted by lead.

The Constitution of the Antimony Tartrates.—F. W. Clarke and Helena Stallo.—The antimony tartrates have generally been regarded as containing as base the univalent group SbO. The authors endeavour to show that this assumption is superfluous, and that they all, or nearly all, are derived directly from trivalent antimony, and that some of them contain a new acid, of which the metal above mentioned is a constituent.

Isopropylen-Neurine.—H. F. Morley.—The author gives an account of the preparation and properties of isopropylen-glycol and of trimethyl-oxy-isopropyl-ammonium.

The History of the Periodic Law.—D. Mendelejeff.

The Combustion-Heat of Benzol.—Julius Thomsen.—The average result for the combustion-heat of gaseous benzol is 805,800 cals.

The Constitution of Benzol.—Julius Thomsen.—The author rejects the theory of Kekulé, maintaining that the six carbons of benzol are connected by nine single bonds. The assumption of a constitution of benzol with three single and three double bonds does not agree with experience.

The Influence of the Isomerism of the Glycols upon the Formation of their Acetic Ethers.—N. Menschutkin.—There is the most complete analogy between the monatomic alcohols and glycols as regards the influence of isomerism upon etherification.

Poly-atomic Alcohols.—N. Menschutkin.—The author examines the boundaries of the systems in which the number of the acetic molecules equals the atomicity of the poly-atomic alcohol, the etherification of poly-atomic alcohols with acetic acid in an equal number of molecules, and the etherification of the acetic systems with an excess of acetic acid.

On Calycine.—O. Hesse.—Calycine is obtained from a lichen named *Calycium chrysocephalum*. It forms gold-coloured prisms of the composition $C_{18}H_{12}O_5$.

Nature of the Caucasian Petroleum.—F. Beilstein and A. Kurbatow.—The Russian illuminating oils excel the American in luminous power by about 10 per cent. Not a trace of the aromatic hydrocarbons can be extracted from the Russian oil by agitation with fuming sulphuric acid. The hydrocarbons of the Caucasian petroleum are poorer in hydrogen than those of the American.

Quantitative Determination of Albumenoids by means of Copper Hydroxide.—G. Fassbender.—The author shows that the attempt to determine the nutritive value of organic matter by ultimate analysis is deceptive. He proceeds as follows:—100 grms. copper sulphate are dissolved in 5 litres water with the addition of 2·5 c.c. glycerin. The solution is then precipitated with a sufficient quantity of soda-lye diluted to 1·5 litre. The liquid must then have an alkaline reaction. The precipitate is poured upon a filter, drained, and rubbed up in a capsule with water which contains per litre 5 c.c. glycerin; more water is added, and the last traces of alkali are removed by repeated decantation or filtration. The precipitate is finally ground up with a little water to which 10 per cent of glycerin has been added, and preserved in well-stoppered bottles. The glycerin does not interfere with its use in the determination of the proteine compounds. (See *Berichte*, xiii., p. 251.)

Inversion of Cane-Sugar by Carbonic Acid, and certain Properties of Inverted Sugar.—E. O. von Lippmann.—Not capable of useful abstraction.

A Reply.—W. Kelbe.—An answer to the "reclamation" of H. E. Armstrong and W. A. Tilden (*Berichte*, xiii., p. 1548).

Occurrence of Saccharine in Osmosised Sugar.—E. O. von Lippmann.—Saccharin is readily formed by the action of hydrate of lime upon inverted sugar, and is readily diffusible.

Evaporation without Fusion.—Lothar Meyer.—The author refers to a paper (*Berichte*, viii., 1627), in which he showed that it depends entirely upon the pressure whether a solid when heated passes at once into the gaseous form and then becomes liquefied. He finds that iodine can be easily melted in a tube exhausted of air if the whole tube is heated to such a degree that the tension of the vapour is everywhere equal to the maximum corresponding to the temperature of the melting-point. As soon as this point is reached the iodine flows down the side of the tube in black streams. If the tube is let cool the liquid iodine begins to boil and congeals again immediately. To melt it into a compact cake it is merely necessary whilst it congeals to keep the upper part of the tube warm, so that no evaporation may occur. If the congealed mass is heated again, Leidenfrost's phenomenon is displayed very strikingly. The mass dances about, rattling loudly, supported by its own vapour. Similar phenomena can be produced with camphor, naphthalin, and perchlorethan; less completely with anthracen and alizarin. The author then criticises the communication of Mr. T. Carnelley (*Nature*, September 9, 1880), and proposes the following modification of his definitions. The "critical temperature" of a substance is that degree of heat above which no pressure is able to liquefy the gaseous substance. The "critical pressure" of a substance is that tension of its vapour below which no access of heat is able to melt the solid substance.

Picene, a New Hydrocarbon from the Tar of Lignite.—O. Burg.—Picene, $C_{22}H_{14}$, is a white hydrocarbon, much resembling chrysene. Its melting-point, corrected is 345° C. It dissolves in sulphuric acid with a green colour, and when heated forms sulpho-acids. With chromic acid and glacial acetic acid it yields a brick-red quinone, and with bromine and chlorine it forms substitution-products. It is possibly identical with the para-chrysen of Rasenack and the pyro-erythrene of Berthelot.

Biebrich Scarlet.—R. Nietzki.—This colouring-matter is obtained by the action of diazo-azo-benzol upon β-naphthol. The basis of these colours is β-naphthol-tetrazo-benzol, a bright reddish powder, insoluble in water and alkalies, sparingly soluble in alcohol, but readily in hot glacial acetic acid. Its melting point is 195°.

The Relations of Echitamine to Ditaine.—O. Hesse.—There is no reason for considering the ditaine salt as distinct from echit-ammonium chloride.

A Glycerin of the Sixth Carbon Series.—W. Markownikoff.—Not suitable for abstraction.

Itaconic Anhydride.—W. Markownikoff.—The author has employed the method of Gerhard and Chiozza for the preparation of anhydrides.

Action of Nitrous Acid upon Anethol.—Paul Tœnnies.—The author caused a solution of sodium nitrite to act upon a solution of anethol in glacial acetic acid, and obtained an addition- and a substitution-product, both which he describes.

Reactive Power of the Naphthols.—C. Graebe.—On heating β-naphthol with aniline hydrochlorate there is formed a new nitrogenous body, β-naphthyl-phenyl-amine. Phenol, under the same conditions, is not converted into diphenyl-amine or aniline. These reactions show the difference between the naphthols on the one hand and phenol on the other. The naphthols are converted by dilute sulphuric acid into the corresponding naphthyl-ethers; β-naphthyl-ether is readily obtained pure and crystalline; α-naphthol-ether much less readily.

α- and β-Naphthyl-phenyl-amine.—J. Streiff.—The author describes α-naphthyl-phenyl-amine, its hydrochlorate and picrate, α-acetyl-naphthyl-phenyl-amine, α-benzoyl-naphthyl-phenyl-amine, α-tribrom-naphthyl-

phenyl-amine, *a*-binitro-naphthyl-phenyl-amine, *a*-naphthyl-phenyl-amin-tetra sulphonic acid, *β*-naphthyl-phenyl-amine; and its trisulpho-acid.

Action of Hydrochloric Acid Gas at Elevated Temperatures upon the Ultramarines of the Series Rich in Silica.—P. G. Silber.—The red ultramarine prepared for some years at the Marienberg Works is obtained by the action of gaseous hydrochloric acid along with air upon blue ultramarine, rich in silica, at a high temperature. A violet ultramarine is obtained as an intermediate product. Ultimately a yellow is produced, of little or no value, which, if heated to redness in a current of hydrogen, becomes blue again.

Cosmos Les Mondes.
No. 17, August 26, 1882.

Process for the Industrial and Economical Production of Hydrogen.—This process is founded on the decomposition of peat, lignite, or other vegetable matters capable of evolving hydrogen proto-carbide, and on the passage of the gas thus generated through a stratum of quicklime, which absorbs the carbon, becomes converted into calcium carbonate, whilst the hydrogen is set free in a state of purity.

Novel Transformation of Petroleum Oil for Lighting Purposes.—MM. Frézon, Dumont, and Francou.—The authors solidify petroleum, in which state it only burns like tallow. They effect the solidification by mixing crude petroleum (after having undergone the first distillation) with 25 per cent of the purified juice of plants belonging to the family of the *Euphorbiaceæ*. The two ingredients are put in a boiler fitted with an agitator, and heated together to about 50°, agitating the whole till the mass becomes a uniform milky fluid. When arrived at this state the mixture is distilled again and refined in the ordinary manner, when it solidifies, and may be used equally well for lighting or as a lubricant.

Numerical Relations between Thermic Data.—Dr. D. Tommasi.—The author proposes the following law:—When a metal is substituted for another in a saline solution the quantity of calories liberated is always the same for each metal, whatever may be the nature of the acid radicle which enters into the salt. Zinc, for instance, when substituted for copper in copper sulphate, liberates 50·6 cals., and the substitution of zinc for copper in any soluble salt of copper liberates always the same quantity. The author gives many examples in illustration of his law.

Annales de la Société des Sciences Industrielles de Lyon.
No. 2, 1882.

Note on Explosives.—H. Boutmy.—A compilation based on the researches of Prof. Abel and MM. Champion and Pellet.

It may be considered singular that an Industrial Society having its seat in Lyon should persistently avoid subjects connected with the tinctorial arts.

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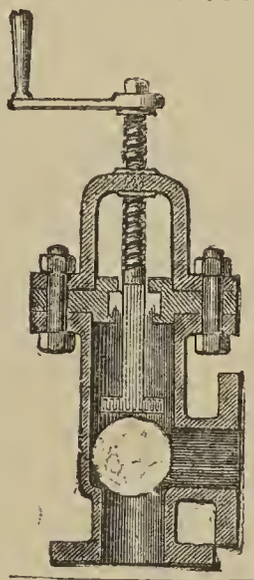

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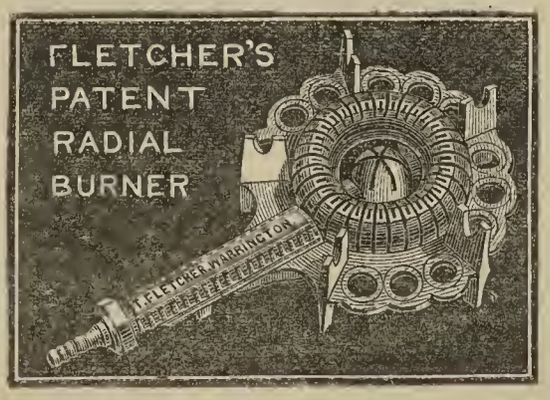

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ANALYSIS BY JOHN PATTINSON, ESQ.

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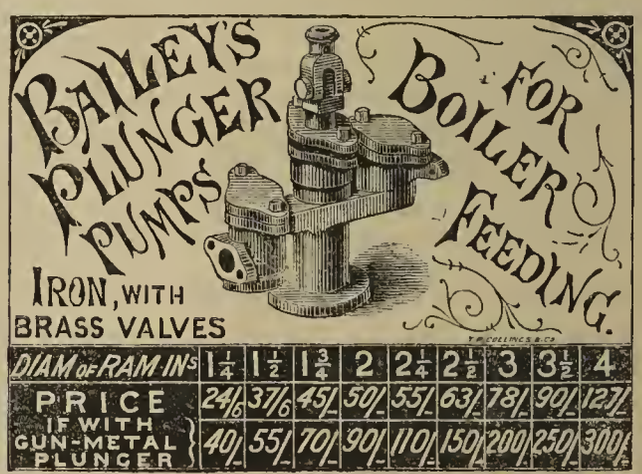

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GOLD MEDAL INTERNATIONAL ELECTRICAL EXHIBITION, PARIS 1881

THE CHEMICAL NEWS.

VOL. XLVI. No. 1194.

ON THE ELECTRIC FURNACE.*

By C. W. SIEMENS, D.C.L., F.R.S.,
and A. K. HUNTINGTON, Professor of Metallurgy, King's College, London.

THE electric furnace has previously been described in the *Journal of the Society of Telegraph Engineers*, June, 1880. It has since been found advisable to surround the furnace with a coil. By this means the direction of the arc can be regulated at will, and the tendency which it has to fly to the sides of the crucible be checked.

The furnace consists of a crucible of any convenient size, in the bottom of which is pierced a hole to receive the positive electrode; the negative electrode, which passes through a hole in the lid of the crucible, being suspended from one end of a beam, the other end of which is attached to a hollow cylinder of soft iron free to move vertically within a solenoid coil of wire. The force with which the cylinder is drawn into the coil can be counterpoised by a sliding weight on the beam. One end of the solenoid coil is connected with the positive, and the other with the negative pole. The coil having a high resistance, its attractive force on the cylinder is proportional to the electromotive force between the electrodes, *i. e.*, to the resistance of the arc. The length of the arc is therefore regulated automatically. This is a point of great importance, as, were it not so, the resistance of the arc would rapidly diminish as the temperature of the atmosphere within the crucible increased, and the result would be that heat would be developed in the dynamo-machine. The extinction of the arc by sudden change in its resistance, or by the sinking of the material in the crucible, is thus also avoided. The crucible is surrounded with some infusible substance which is also a bad conductor of heat. Gas-retort carbon or sand answers well for the purpose. The electrodes may be of such carbon as is used in electric lighting, or of any other convenient conducting substance. They may, if desired, be cooled by circulating water through or round them, or by exposing them as far as possible to the air. For example, in one experiment a ½-inch nickel positive pole was employed, the lower end being inserted into a solid rod of copper about 1 inch square by 6 inches long. With this pole, no other means of keeping it cool being adopted, 1 lb. of grain nickel was fused in a clay crucible and poured in eight minutes, starting with all cold. The electrode was but little attacked, and no leakage occurred.

There are two great advantages possessed by the electric furnace, viz., that the temperature attainable is practically only limited by the refractoriness of the materials of which the furnace is constructed, and that the heat is developed immediately in the material to be fused, instead of first having to pass through the containing vessel. The temperature to be obtained by the use of fuel is limited by dissociation. Deville has shown that carbonic acid undergoes dissociation at the ordinary atmospheric pressure at about 2600° C.—4700° F.

In the experiments made by the authors five D 2 machines, driven by a Marshall's 12 horse-power engine, were employed, one being used as an exciter. The current ranged between 250 and 300 Ampères. The most refractory clay crucibles supplied by the Patent Plumbago Crucible Company were invariably cut through in a few minutes, and, except for experiments of short duration, were useless. Plumbago crucibles stood exceedingly well. Obviously, however, they could not be employed for all purposes, owing to their tendency to cause carburisation of the metal experimented with. In some experiments the fusion of metal was effected in a bed of lime, sand, or electric light carbon-dust. The latter is a very bad conductor, and, as in the case of lime and sand, allows the arc when once formed to maintain a passage through it to the metal beneath.

Wrought-Iron.—Six pounds of wrought-iron were kept under the action of the arc for twenty minutes, and the metal then poured into a mould. It was found to be crystalline, and could not be forged. This is the result which has always been obtained when iron, nickel, or cobalt have been fused. Although the remedy, viz., the addition of a little manganese just before pouring, is well known, the cause remains still unexplained.

Steel.—As much as 20 lbs. of steel files have been melted in one charge, the time required being about one hour, starting with the furnace hot. With such large quantities the metal has invariably been full of blowholes.

White iron, fused in a clay crucible for thirty minutes, when fractured did not appear to have undergone any change. White iron and coke were introduced into the furnace; the resultant metal was slightly greyer than the original. When, however, retort carbon was substituted for the coke, a good grey iron, soft and easily workable, was readily obtained in fifteen minutes, starting with the crucible hot. On another occasion, starting all cold, at the end of thirty minutes the metal, although it had been well fused, had not been rendered greyer. The difference between these two results was possibly due to the temperature being somewhat higher in the one case than in the other. This is a point of considerable practical interest. Four pounds of white iron, fused with carbon-dust for three-quarters of an hour, yielded a very grey crystalline iron. In another experiment, in which 8 ounces of grey iron, produced in the electric furnace from white iron, were re-melted in carbon-dust for ten minutes, a very grey metal was obtained, from which on slow cooling a large quantity of graphite separated.

Cast-iron, fused and kept under the action of the arc for forty-five minutes in carbon-dust, was not materially changed as to greyness, and the general character of the metal as to the way in which it worked under the tool was not materially altered. The object of the experiment was to ascertain the maximum amount of carbon iron is capable of taking up under circumstances presumably the most favourable. The result is hardly that which would have been anticipated. Some of the same cast-iron was fused for fifteen minutes under lime, which nearly covered it. The character of the fracture of the metal was but little altered by this treatment, when slight differences, due to the rate of cooling, are taken into account. A strong smell of phosphuretted hydrogen or of a phosphide was perceived—probably the latter. This was only observed in the experiment in which lime was used. The lime employed still retains a very offensive odour.

When *spiegeleisen* was fused in a plumbago or a clay crucible, graphite separated as the metal cooled.

Siliceous pig iron, containing about 10 per cent silicon, was fused by itself; it showed but little change, except that some graphite separated. A similar result was obtained when 5 lbs. of the siliceous pig were fused for one hour in carbon-dust. On fracturing the ingot obtained, a large quantity of scales of graphite was found in a hollow which traversed nearly the whole length of the ingot at its centre. The fracture of the metal was still that so characteristic of highly siliceous iron, and was practically the same as that of the original pig-iron.

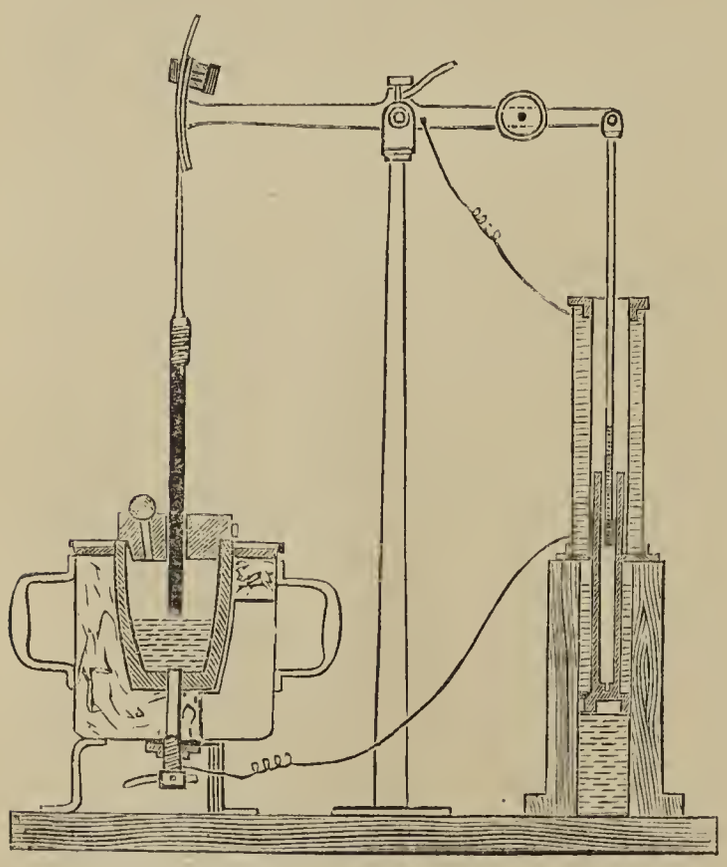
A series of experiments was made to determine the maximum amount of carbon pig-iron is capable of taking up in the presence of a given quantity of silicon. Grey cast-iron and pig-iron containing 10 per cent of silicon were fused together in carbon-dust, the ratio between them being varied so as to yield metal with from ¼ per cent to 9 per cent of silicon.

A similar series was made, only substituting sulphur for silicon. No odour of sulphurous acid was perceived;

* Read before Section B of the British Association at Southampton.

therefore, presumably, no sulphur was volatilised. This is somewhat remarkable, considering the nature of the experiment. It was thought that investigations of this kind might have an important practical as well as more purely scientific interest—admitting, for the sake of argument, that any such distinction really exists—in assisting to determine the conditions in the blast-furnace, &c.

Nickel.—A positive pole of this metal,—cast malleable by Wiggin and Co.'s process,*—½ inch in diameter, was passed through a hole in the bottom of a clay crucible. A carbon negative pole was used, but soon after the commencement of the experiment a deposit of nickel formed on the end of it, so that practically it was a nickel pole. This deposition of metal on the negative pole was also observed with some other metals—notably with tungsten. Without disclaiming any special knowledge on the point, Prof. Huntington suggested whether this phenomenon—which is the reverse of that generally recognised as taking place—might not depend on the relative volatility of the matter composing the poles. In the furnace arranged as just described, 1 lb. of grain nickel was fused and poured in eight minutes. The fused metal had a brilliant granular fracture. It could not be cut properly in the shaping machine, shearing off under the tool. One pound of grain nickel fused in carbon-dust for twenty-five minutes yielded a dark grey carburised metal, which worked well under the tool. On another occasion an equal quantity of nickel, similarly treated, gave a "blowy" metal, which could not be worked. Some carburised nickel, made as described above, was fused in a clay crucible for twelve minutes, and allowed to cool gradually in the furnace; the fracture became whiter, and the grain closer.



Copper.—Three-quarters of a pound of copper were fused for about half an hour in carbon-dust. On examining the result it was found that all but about ¾ oz. had been vapourised. Those who were present during the experiments suffered no ill effects from the atmosphere charged with copper, which they must have breathed.

Platinum.—Eight pounds of platinum were rendered perfectly liquid in about a quarter of an hour.

* See paper on "Nickel and Cobalt," by A. K. Huntington, in July number of the *Journal of the Society of Chemical Industry.*

Tungsten.—Half a pound of tungsten in powder was subjected to the action of the arc in a clay crucible. Dense fumes were evolved, a cavity about 1½ inches across the top being formed. The furnace was allowed to cool down slowly. When the crucible was removed it was found to have been very much attacked below the point to which the arc extended. The inference is that the crucible had been attacked by the metal at the temperature of the experiment. The metal was fused only to an inappreciable depth beneath the cavity formed by the arc. The unfused metal underneath was covered with very beautiful iridescent crystals of tungsten, which under the microscope appeared to be well formed prisms. They have not yet been measured. The crystals had evidently been formed by the slow cooling of the vapour distilled down from the surface.

A very large number of experiments was made with tungsten, the results of which showed that it could not be fused, except in very small quantities at a time. It was possible to build up a small ingot by fusing a little of the tungsten, and then adding little by little gradually. Even then the pieces obtained were for the most part spongy and unsatisfactory. The best results arrived at were when tungsten which had already been fused was employed in the building up process. Once the metal had been fused, it did not fume much in melting, doubtless owing to the greatly reduced surface exposed.

Tungsten fused in the electric furnace is, when untarnished, pure white and brittle, the grain being very close. Tungsten hitherto has only been obtained as a grey powder, by reducing the oxide with carbon or hydrogen, or in minute globules in the ordinary small electric arc. Tungsten has its fusing point lowered by the addition to it of carbon. Under these conditions a solid piece of moderate size can, without much difficulty, be obtained. From 1000 grains of powder fused in carbon-dust, 650 grains were recovered, the remainder having been volatilised, and from 450 grains of the fused metal 410 grains were obtained on re-fusion. One piece of tungsten which had been treated under the conditions most likely to cause it to be highly carburised was analysed. It contained 1·8 per cent of carbon. The metal was very white, close in grain, and brittle.

From the foregoing experiments it is clear that the amount of any given metal which can be successfully fused in the electric furnace, and the time required in effecting the fusion, are dependent on (*a*) the relation between the volatilising point and the fusing point, *i.e.*, the extent to which the volatilising point is higher than the fusing point; (*b*) the conductivity of the metal for heat.

It thus happens that platinum can be more readily melted than steel, and in greater quantity for a given expenditure of energy. This inference is believed by Prof. Huntington to be justified by the observations and experiments so far made.

It still remains to examine chemically the specimens referred to in this paper.

In the discussion on the communication made by Prof. Huntington, Dr. SIEMENS remarked that the limit of the temperature producible by means of the electric furnace is as yet unknown, for although the heat would probably increase the resistance of the arc, that in itself would only cause a further development of heat. The results obtained with copper, although apparently pointing to a drawback in the use of the furnace for melting purposes, yet might prove of importance in dealing with metals in the vaporous condition. He could not agree with Prof. Huntington's suggestion as to the cause of the deposition of metal on the negative pole. He thought it was due to the negative pole being much cooler than the positive.

Dr. GLADSTONE inquired whether the deposit was crystalline or in fused globules.

Prof. HUNTINGTON replied that it was in the latter condition.

Mr. TERRILL (Swansea) remarked that the loss of copper by volatilisation in smelting was much greater than it was

generally supposed. During an accidental escape of sulphuretted hydrogen in the works he had observed a thick deposit of sulphide of copper extending over a large area. He had detected copper deposited even on the zinc counter of the refreshment bar at the railway station some distance from the works.

The discussion was continued by Mr. Maxwell Lyte, Prof. Vernon Harcourt, and the president, Prof. Liveing, who thought that such experiments as had been made might be of great service in the study of metals.

RATTLESNAKE POISON.

By HENRY H. CROFT,
Late Professor of Chemistry, &c., Toronto, Canada.
Formerly part Editor and originator of the *Chemical Gazette*.

Some time since, in a paper to which I am unfortunately unable to refer, a French chemist affirmed that the poisonous principle in snakes, or eliminated by snakes, was of the nature of an alkaloid, and gave a name to this class of bodies.

Mr. Pedler has shown that snake poison is destroyed or neutralised by means of platinic chloride, owing probably to the formation of an insoluble double platinic chloride, such as is formed with almost if not all alkaloids.

In this country (Texas) where rattlesnakes are very common, and persons camping out much exposed to their bites, a very favourite antidote, or *remedia* as the Mexicans call it, is a strong solution of iodine in potassium iodide.*

I have had occasion to prove the efficacy of this mixture in two cases of *cascabel* bites, one on a buck the other on a dog, and it occurred to me that the same explanation of its action might be given as above for the platinum salt, viz., the formation of an insoluble iodo compound as with ordinary alkaloids if the snake poison really belongs to this class.

Having last evening killed a moderate sized rattlesnake —*Crotalus horridus*—which had not bitten anything, I found the gland fully charged with the white opaque poison; on adding iodine solution to a drop of this a dense light-brown precipitate was immediately formed, quite similar to that obtained with most alkaloids exhibiting under the microscope no crystalline structure.

In the absence of iodine a good extemporaneous solution for testing alkaloids, and perhaps as snake poison antidote, may be made by adding a few drops of ferric chloride to solution of potassium iodide: this is a very convenient test agent which I used in my laboratory for many years.

Although rattlesnake poison could be obtained here in very considerable quantity, it is out of my power to make such experiments as I could desire, being without any chemical appliances and living a hundred miles or more from any laboratory. The same may be said with regard to books, and possibly the above iodine reaction has been already described.

Dr. Richards states that the cobra poison is destroyed by potassium permanganate; but this is no argument in favour of that salt as an antidote. Mr. Pedler also refers to it, but allows that it would not be probably of any use after the poison had been absorbed. Of this I think there can be no doubt, remembering the easy decomposition of permanganate by most organic substances, and I cannot but think that the medicinal or therapeutic advantages of that salt, taken internally, are equally problematical, unless the action is supposed to take place in the stomach.

In the bladder of the same rattlesnake I found a considerable quantity of light brown amorphous ammonium urate, the urine pale yellow.

Hermanitas Ranch, 35 San Diego, Duva Co., Texas, U.S., August 22, 1882.

* The solution is applied as soon as possible to the wound, preferably enlarged, and a few drops taken internally. The common Mexican *remedia* is the root of the *Agave Virginica* mashed or chewed and applied to the wound, while part is swallowed.

Great faith is placed in this root by all residents here, who are seldom without it, but I have had no experience of it myself; and the internal administration is no doubt useless.

Even the wild birds know of this root; the queer Paisano (? ground woodpecker) which eats snakes, when wounded by a *vibora de cascabel*, runs into the woods, digs up and eats a root of the Agave, just like the mongoose; but more than that, goes back, polishes off his enemy, and eats him. This has been told me by Mexicans who, it may be remarked, are not *always* reliable.

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

(Continued from p. 152).

Separation from Uranium (yellow uranic salts). The four following methods are suitable for exact analyses:—

1. The hydrochloric solution, slightly acid, is treated at a boil with an excess of cupric hydrate. The deposit contains all the gallium as well as a very sensible portion of uranium. It is re-dissolved in hydrochloric acid, diluted with water, and boiled in presence of a large excess of cupric hydrate. With from 10 to 15 parts of uranium to 1 of gallium, four successive precipitations are required. The uranium is then entirely contained in the liquids which are acidified, and are then traversed by a current of sulphuretted hydrogen. Copper sulphide is deposited, and the salt of uranium is obtained on evaporating the filtrate.

2. If there is iron to remove along with uranium it is first reduced in heat with metallic copper and then boiled with an excess of cuprous oxide. Four successive operations suffice to separate completely 1 part gallium from 10 to 15 parts uranium. The presence of very considerable quantities of alkaline salts does not interfere with the execution of the two methods just described, which may serve for the analysis of a mixture of gallium and of an alkaline uranate.

3. The hydrochloric solution, slightly acid, is mixed with an excess of acid ammonium acetate, as also a certain quantity of zinc free from gallium, and is then treated with a current of sulphuretted hydrogen. The zinc sulphide carries down the gallium, whilst the uranium remains in solution. Only the zinc sulphide being very difficult to wash ought to be re-dissolved in hydrochloric acid and re-precipitated in an acetic solution. The gallium is separated from the zinc as was described previously (*Comptes Rendus*, June, 1882, p. 1628). The uranium is separated by evaporating the liquids with an excess of hydrochloric acid to expel acetic acid, and then destroying the ammoniacal salts with *aqua regia*. It is essential to add to the liquid so much zinc chloride that the zinc sulphide may carry down all the gallium. Some drops of zinc chloride should be added to the filtered hydro-sulphuretted liquids to ascertain the absence of gallium in this last zinc sulphide. Alkaline salts do not interfere with the separation of uranium and gallium by means of zinc sulphide. The present process is suitable for the detection of small traces of gallium in large masses of uranic compounds, especially in presence of metals such as aluminium. But in ordinary cases it is better to make use of the reactions of copper hydrate or of metallic copper and cuprous oxide.

4. Uranium may be precipitated by a slight excess of caustic potassa as an alkaline uranate, scarcely retaining a slight trace of gallium, which may be entirely removed by re-dissolving in hydrochloric acid and re-precipitating with potassa. The alkaline liquids collected contain all the gallium and traces of uranium. These liquids are slightly supersaturated with hydrochloric acid mixed with an excess of cupric hydrate and raised to a boil, when the gallium is completely precipitated. In the filtrate, copper, uranium, and potassium are separated by known methods. When the potassa employed contains a little carbonate (a

frequent case) the proportion of uranium not precipitated is sensibly increased; this is without inconvenience, since the separation of this gallium and of the dissolved uranium is effected afterwards by the action of cupric hydrate.

Separation from Lead.—This may be effected in six methods:—

1. The hydrochloric solution, slightly acid, is diluted with a little water and submitted to ebullition in presence of an excess of cupric hydrate. The gallium precipitated retains but a feeble trace of lead, which is entirely eliminated by a second similar treatment. The reagents employed must be free from sulphuric acid or sulphates, or otherwise lead sulphate will remain upon the filter along with gallium oxide. The copper and the lead are then separated by known methods. The present process is very exact, and is suitable for removing from gallium sulphate the small quantity of lead which remains in solution after precipitation with sulphuric acid.

2. The separation of lead is also effected accurately if the hydrochloric or sulphuric solution is boiled first with metallic copper and then with cuprous oxide. This method is especially applicable when iron has to be separated at the same time as lead. The first cuprous precipitate contains scarcely a feeble trace of lead, so that two operations are sufficient. If we operate upon a chloride the presence of sulphuric acid must be carefully avoided.

3. The solution, sulphuric, hydrochloric, or nitric, perceptibly though moderately acid, is saturated with hydrogen sulphide, filtered, and evaporated almost to dryness, in order to expel the bulk of the free acid. It is then diluted with water, and again saturated with hydrogen sulphide. After two or three similar treatments, the salt of gallium no longer contains an appreciable trace of lead. The lead sulphides generally retain a trace of gallium, which may be removed by attacking them with concentrated hydrochloric acid, adding alcohol, filtering, evaporating to expel the alcohol and the bulk of the acid, diluting with water, and finally saturating with sulphuretted hydrogen.

4. In a liquid containing from one-fourth to one-third of its volume of strong hydrochloric acid, potassium ferrocyanide precipitates gallium ferrocyanide, generally free from lead. In case of need the gallium salt may be taken up in a small quantity of potassa and re-precipitated by adding much hydrochloric acid and a little potassium ferrocyanide.

5. It is often convenient to begin by precipitating almost all the lead by means of sulphuric acid. The liquid is then mixed with double its volume of alcohol at 90°. If properly washed with alcohol, acidulated with sulphuric acid, the lead sulphate does not contain appreciable traces of gallium. To detect such traces the lead sulphate is suspended in water, acidulated with hydrochloric acid, and treated with a prolonged current of hydrogen sulphide. The filtrate is boiled in order to expel hydrogen sulphide, and treated in heat with cupric hydrate, which precipitates the traces of gallium oxide. The alcoholic solutions derived from the sulphuric precipitation of lead are freed from alcohol by boiling; the gallium oxide is then separated by means of cupric hydrate.

6. The solution (nitric or other) is mixed with twice its volume of alcohol at 99 per cent, and a small excess of hydrochloric acid. The lead chloride when washed with acidulated alcohol does not retain gallium. The alcoholic liquids are concentrated to a small volume, freed from nitric acid, and treated either with hydrogen sulphide (process No. 3), or with cupric hydrate, or metallic copper and cuprous oxide (processes Nos. 1 and 2).—*Comptes Rendus.*

New Work on Dyeing.—We learn that Messrs. Palmer and Howe, of Manchester, have in the press a new work on dyeing by Mr. David Smith, of Halifax. The work will contain 500 dyed patterns of cotton yarns, cotton wool, worsted yarns, wool, and silk in the skein, each accompanied by a practical receipt.

CHEMICAL LITERATURE.

An Address Delivered before the American Association for the Advancement of Science, at Montreal, August 23, 1882.

By Prof. H. CARRINGTON BOLTON, Ph.D., Vice-President.

(Concluded from p. 148).

As we proceed with this review of chemical literature, the publications increase enormously in number, variety, and importance, and the end of our undertaking seems to move forward faster than we progress. It is manifestly impossible in the brief time allotted to this address to analyse the chemical literature of the preceding hundred years. How shall we attempt to portray the theories and experiments recorded in the writings of Bergmann,* Scheele † and Gahn, the eminent Swedes; of Black,‡ Cavendish,§ and Priestley,‖ the English triumvirate; of the French philosophers Fourcroy,¶ de Morveau,** and Lavoisier;†† of the industrious German chemists Kunckel,‡‡ Marggraf,§§ Wenzel,‖‖ Klaproth,¶¶ and Richter;*** or of the Italian philosophers Galvani,††† Volta,‡‡‡ and Brugnatelli?§§§ And passing to a later period, how shall we do justice to the labours of Berthollet,‖‖‖ Gay-Lussac,¶¶¶ Thénard,**** and Laurent;†††† of the immortal Dalton,‡‡‡‡ of the brilliant Davy,§§§§ of the indefatigable analyst Berzelius;‖‖‖‖ of Mitscherlich, Liebig, Wöhler, and Hofmann; of Dumas, Berthelot, and Adolph Wurtz; of Graham, Frankland, Abel, and Crookes?

American contributions to chemical literature have been exhaustively discussed in the hearing of many present and need not now detain us; I refer to Prof. Silliman's Address at the celebration of the centenary of Priestley's discovery of Oxygen, held at Northumberland in 1874.¶¶¶¶

(Works marked (*a*) are in the private library of the author.)

* Torbern Bergmann, *Opuscula physica et chemica.* 6 vols., 1779-1790. Cf. (*a*) "Physical and Chemical Essays," translated by Edmund Cullen. London, 1784. 2 vols. 8vo.

† Carl Wilhelm Scheele, *Opuscula chemica et physica.* Leipzig, 1788. Cf. (*a*) *Mémoires de Chymie.* Dijon, 1785. 2 vols. 12mo.

‡ Joseph Black, "Lectures on Chemistry." London, 1803. Cf. An (*a*) American edition published at Philadelphia in 1807. 3 vols. 8vo.

§ Henry Cavendish, (*a*) "The Life of Henry Cavendish, including abstracts of his more important scientific papers," by George Wilson. London, 1851. "Electrical Researches, edited from the original MSS.," by J. Clerk Maxwell. Cambridge, 1881.

‖ Joseph Priestley, (*a*) "Experiments and Observations on different kinds of Air." London, 1775. 4 vols. Priestley's earliest chemical paper was entitled: (*a*) "Directions for impregnating Water with Fixed Air." London, 1772.

¶ A. Fr. de Fourcroy, *Systeme des connaissances chimique.* Paris, 1801; *Tableaux synoptiques de chimie,* Paris, 1799; *Memoires et Observations de chymie.* Paris, 1784.

** Guyton de Morveau, (*a*) *Methode de nomenclature chimique.* Paris, 1787. *Elements de chimie . . . pour servir aux Cours publics de l'Academie de Dijon,* 1777. *Encyclopedie methodique de chimie,* 1786.

†† Ant. Laurent Lavoisier, *Oeuvres complets.* Paris, 1862.

‡‡ Johann Kunkel, *Collegium physico-chymicum experimentale seu Laboratorium chymicum.* Berlin, 1716. [(*a*) *Vierte Auflage,* 1767].

§§ Andreas Sig. Marggraf, *Chymische Schriften.* Berlin, 1761 and 1767. 2 vols. 8vo.

‖‖ Carl Fr. Wenzel, *Vorlesungen über die chemische Verwandtschaft der Körper.* Dresden, 1777. 8vo.

¶¶ Martin H. Klaproth, *Beiträge zur chemischen Kenntniss der Mineralkörper.* Berlin, 1795-1815. 6 vols. 8vo.

*** J. B. Richter, *Stöchiometrie oder Messkunst chymischer Elemente.* Breslau, 1792-1794. 3 vols.

††† Luigi Galvani, *Opere edite ed inedite.* Bologna, 1841. 4to.

‡‡‡ Alessandro Volta, *Collezione dell'opere* [edited by V. Antinori]. Firenze, 1816. 3 vols. 8vo.

§§§ Luigi Brugnatelli, *Elementi di chimica,* Pavia, 1795. 2 vols.; also *Annali di chimica,* 1790-1793, and several other periodicals.

‖‖‖ Claude Louis Berthollet, *Essai de Statique chimique.* Paris, 1803. 2 vols.

¶¶¶ Gay-Lussac, *Recherches physico-chimiques faites sur la pile, &c.,* Paris, 1811. 2 vols. 8vo.

**** Louis Jacques Thénard, *Traite de chimie elementaire.* Paris, 1813-16. 4 vols. 8vo.

†††† (*a*) Auguste Laurent, "Chemical Method," translated by Wm. Odling. London, 1855.

‡‡‡‡ (*a*) John Dalton, "A New System of Chemical Philosophy." Manchester, 1808. 2 vols. 8vo.

§§§§ Sir Humphry Davy, "Collected Works," edited by John Davy. London, 1839-41. 10 vols. 8vo.

‖‖‖‖ J. J. Berzelius, *Lehrbuch der Chemie* [(*a*) *fünfte Auflage.* Leipzig, 1856. 6 vols. 8vo.]

¶¶¶¶ (*a*) Benjamin Silliman, "American Contributions to Chemistry,"—in the *American Chemist,* vol. 5, p. 70. Philadelphia, 1874.

The modern period of chemical literature is characterised by two opposing forces, a tendency to dispersal and an effort to collect the widely-scattered publications. The multiplication of learned societies, especially in Europe, each of which supports its own organ, and the increasing number of nations interested in scientific pursuits, in each of which arises an independent periodical, tend to the wide dispersal of memoirs, essays, and notices.

On the other hand, industrious editors laboriously collect and set in order these scattered observations, constructing compact, massive handbooks, and many volumed cyclopædias. The monumental work of Gmelin, which is even now passing through another edition, has worthy rivals in the magnificent compilations edited by Henry Watts and by Adolph Wurtz, and in the work of Beilstein in a field of special difficulty. For systematic treatises we can point to Miller, Graham-Otto, Pelouze et Frémy, Roscoe and Schorlemmer, and the ever youthful Fownes.

Invaluable, too, are the annuals known as *Jahresberichte*, monuments of conscientious editorship.

Another feature of modern growth is the multiplication of special treatises dealing with single topics in every branch of chemistry, inorganic, organic, theoretical, analytical, technological, pharmaceutical, and physiological, until mere acquaintance with their titles becomes a serious undertaking for busy workers in the laboratory.

The amount of time and labour required to search for a given point throughout the maze of modern chemical journals, transactions, treatises, and handbooks, is well appreciated by my audience; the superb dictionaries and annuals referred to accomplish much in cataloguing, condensing, and systematising the infinity of observations; nevertheless, all working chemists feel the need of special indexes, simply arranged, as complete as possible, and accessible to every one. Sharing in this feeling, I have contributed my mite to the literature of chemical indexes, and have inspired several friends, fellow-members of this Association, with the courage to follow. Uranium,* Manganese,† Titanium,‡ Vanadium,§ Ozone,‖ and Peroxide of Hydrogen,¶ have been indexed on a uniform plan, and my pupil W. W. Webb, B.S., has prepared an Index to the Literature of Electrolysis,** which will soon be published in the same channel as the others:—the "Annals of the N. Y. Academy of Sciences."

Pardon, we beg you, these personal allusions: we have indulged in them with the object of bringing before this Section a proposition for organised effort in the preparation of Indexes to all the Elementary Substances on a uniform plan.

The advantages which would accrue from the publication of special indexes to the literature of the elements and of such other subjects as may prove desirable are too obvious to need argument; I have thought that the undertaking might be placed in the hands of a Committee of the Chemical Section of this Association. The existence of an Index Society in England under the guidance of Henry B. Wheatley, F.S.A., Hon. Sec., affords a precedent, if indeed any be required.

The first duty of the Index Committee of the Section of Chemistry would be to secure volunteers willing to undertake the compilation of special indexes; surely in this National Association a few chemists can be found ready to coöperate in such an important work. The Committee would further adopt a uniform plan for the indexes, determine the method or channel of their publication, and exercise general editorial supervision over the undertaking.

Hoping that this suggestion will receive your approbation I leave it in your hands.

* H. C. Bolton, "Index to the Literature of Uranium." Annals N. Y. Lyc. Nat. Hist., IX, Feb., 1870.

† H. C. Bolton, "Index to the Literature of Manganese." *Idem*, XI., Nov., 1875.

‡ Edw. J. Hallock, (*a*) "Index to the Literature of Titanium." Annals N. Y. Acad Sci. I., p. 53.

§ G. J. Rockwell, (*a*) "Index to the Literature of Vanadium." *Idem*, I., p 133.

‖ A. R. Leeds, (*a*) "Index to the Literature of Ozone." *Idem*, I., p. 373.

¶ A. R. Leeds, (*a*) "Index to the Literature of Peroxide of Hydrogen." *Idem*, I., p. 416.

** W. W. Webb, "Index to the Literature of Electrolysis." *Idem* vol. II., p. —.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

By A FOREIGN VISITOR.

Although twenty years younger than its great prototype, the British, this Association is nevertheless in active and vigorous growth. The thirty-first meeting, which has just concluded its session at Montreal, will henceforward rank as one of the most successful of its many successful reunions. Favoured with splendid weather (not so hot as the usual Canadian summers), a picturesque and yet important commercial city wherein to assemble, and a most energetic and liberal Local Committee, how could anything go wrong? But success means work, and this fact every member of the executive seemed to realise, for all worked with a will.

To give names under these circumstances would seem invidious, but three gentlemen stand out in such prominence that any account of the 1882 meeting would be incomplete were they not specially mentioned. This Montreal Triumvirate consisted of Dr. T. Sterry Hunt, F.R.S., the Chairman of the Local Executive; Mr. F. W. Putnam, the Permanent Secretary of the Association; and Prof. H. T. Bovey, the Secretary of the Local Committee on Excursions, and may every Society have such disinterested workers!

The head quarters of the Association were situated at McGill University, but some of the larger meetings were held in the Queen's Hall (a very fine building), in the heart of the city. *En passant* we may say that McGill University was founded by the generosity of the Hon. James McGill, a native of Glasgow, but a resident of Montreal. This gentleman, who died in 1813, left 47 acres of land and £10,000 in money, "to erect and establish a University or College for the purpose of Education and the advancement of learning in the Province of Lower Canada." The first session commenced in the autumn of 1821, when a Royal charter was granted. Since that it has grown slowly and steadily, until to-day it ranks as one of the leading universities of the American continent. This success has been greatly due to the munificence of many of the leading citizens of Montreal, who have contributed large sums to the funds at the disposal of the Governors. The Principal of the College, Dr. J. W. Dawson, F.R.S., was President of the Association for the meeting, and it is needless to say the University was exceedingly well represented.

The arrangements of the Local Committee were very complete and satisfactory. They are, however, in many respects so different, owing to circumstances, to those in use by us that a short account of them may not be out of place. In the first place every railway company owning lines running into Montreal agreed to take members to and fro for a single fare. As it is the custom for the head of the family to bring his wife, and perhaps a daughter or two, this becomes an important concession. Upon registering their names, members receive a handbook of Montreal and a badge stamped with the number against his or her name on the register. This badge it is expected will be worn during the meeting. The handbook was exceedingly well done, and contained a good map of the town, which we strangers found of immense service. Luncheon was provided daily in a spacious marquee erected in the College grounds. The telegraph companies showed their sense of the presence of the representatives of science in their midst by placing, in a room of the College set apart for that purpose, transmitting and re-

ceiving instruments, and a telephone, and keeping an operator in attendance. Messages could be sent by members to any part of the United States or Canada free of charge. I fear our Government do not treat British men of science with like liberality. Again, any parcels of books, drawings, instruments, or specimens were delivered free of charge by the various Express companies. The Collector of Customs admitted such parcels from the States free of duty. But perhaps the most surprising to an English visitor was the extraordinary generosity of the railway companies in the matter of excursions. Three of these were arranged, one on Saturday, August 26, to Ottawa (112 miles from Montreal) and back, another starting on Friday night and returning on Saturday down the St. Lawrence to Quebec (160 miles from Montreal), and the third to Lake Memphremagog (120 miles) on Thursday, August 31. (The distances of these excursions are worth noting: imagine the British Association at its last meeting running excursions to Plymouth, Canterbury, and Gloucester!) In each of these cases special trains were placed at the service of the scientists. In the Quebec excursion, the Richelieu and Ontario Steamboat Company provided dinner for 500 free of cost, and the South Eastern R. R. Company, who gave the Memphremagog excursion, not only provided dinner for a like number, but chartered a steam-boat to take them for a trip on this beautiful lake. In addition to this every member could go any morning or evening simply by showing his badge by the Grand Trunk R.R. to Lachine, then embark on board a steamboat, and come down the Lachine Rapids under the Victoria Bridge to Montreal.

The proceedings were opened on Wednesday, August 23, by a General Meeting in the Molson Hall of McGill College. Here the retiring President, Prof. Geo. J. Brush, resigned the chair to Dr. Dawson, the incoming President. An invocation by the Right Rev. Bishop Bond followed, after which Dr. Hunt gave a short History of the Association, which was then formally welcomed to the city by the Hon. J. L. Beaudry, the Mayor. The President next announced the names of the foreign visitors, as follows:—Dr. W. B. Carpenter, Dr. J. H. Gilbert, and Dr. Rae, from London; Dr. Haughton, from Dublin; Mr. E. H. Cook, from Bristol; Prof. Szabo, from Buda Pesth; Prof. W. Kowalevski, from Moscow; and M. Rudolph Kœnig, from Paris. Each of these contributed one or more papers to the Association. In addition there were present Dr. Fitzgerald and Messrs. Ormsley and McCays, from Dublin; Rev. Prof. Wiltshire and Mr. J. S. Shene, from London; Mr. J. Cox, from Cambridge; and Herr C. Wedl, from Vienna.

After a resolution had been carried to cablegram to Dr. Siemens at Southampton, the meeting adjourned for lunch provided by the Local Committee. In the afternoon the addresses of the Presidents of the Sections were given. The total number of persons registered amounted to 937, a number that has only been exceeded once before, viz., at the Boston meeting two years ago. The total number of papers read amounted to 256, divided between the nine sections. In addition to this there was the address of the retiring President, Prof. Brush, on "Mineralogy," addresses by the Vice-Presidents in eight of the sections, and two public lectures, one by Dr. Carpenter on "The Temperature of the Deep Sea," and one by Prof. Alexander Melville Bell on "Visible Speech." It is thus evident that no one could complain of the amount of scientific pabulum provided, and the quality was also of a high order. It may interest the curious, and perhaps also the critical, to know that out of the 937 persons registered no less than 367 were ladies, who contributed eight papers to the number read. The whole of the addresses of the various Vice-Presidents were highly interesting, and every paper communicated was of scientific interest. Among those which attracted most attention we may perhaps mention Sir J. B. Lawes and Dr. Gilbert on "Sources of Nitrogen in Crops," read before Section C., and ordered to be printed *in extenso*; Dr. Haughton's paper upon "Possible Geological Consequences of the Evolution of the Earth-Moon System," in which he notices and criticises Mr. Darwin's recent work; Prof. Asa Gray "On the Flora of North America," a summary of the knowledge acquired during a life-long study of the subject; Dr. John Rae's most interesting account of his Arctic Explorations in search of traces of Sir John Franklin; Prof. A. Graham Bell on his experiments in finding the position of a bullet when hidden in the body, with exhibition of the apparatus; Prof. H. A. Rowland's exhibition of his beautiful diffraction gratings; and last, but not least, M. Kœnig on the "Influence of Harmonics on the Timbre of Sound."

During the meeting Mr. Peter Redpath formally presented his new Museum to Principal Dawson for the use of McGill University. This really fine building stands in the College grounds, at a short distance from the main building, and has been erected and fitted up at the sole expense of the generous donor, an expense estimated at 100,000 dollars. Its cases are already well-filled, including Dr. Dawson's collection, which he has recently presented to McGill University, and also the very fine collection of shells left by Dr. P. Carpenter, of Montreal.

The meeting of 1882 will long be remembered by the visitors from this side of the Atlantic. Not only were they treated to science of a very high class, but the cordial and generous manner in which they were received is seldom equalled, and never excelled. We had heard of the hospitable character of the Canadian and American people, and our expectations were great: we have now experienced this hospitality, and our expectations were greatly surpassed. Moreover, in the ability and enthusiasm displayed by all the younger men we could not help feeling that in such hands American science must flourish and must extend its operations to the benefit of mankind in general.

We cannot conclude this brief notice without placing on record and heartily endorsing the sentiments expressed in the address of welcome presented to us by the citizens of Ottawa:—"The mission of Science is not only to civilise the nations; it is also in an eminent degree to unify them by increasing the intimacy at once of social and international relations, and by creating for the contemplation and use of all a solid body of truth whose authority is wholly independent of latitude and longitude. The writ of science runs throughout the universe. . . . . Let us at the same time express the hope that the great English-speaking branches of the human family may ever draw nearer to one another in heart, and so encourage and strengthen one another, in the practice of every national virtue, and in the promotion of peace, progress, and human happiness throughout the world."

NOTICES OF BOOKS.

On Artificial Manures: their Chemical Selection and Scientific Application to Agriculture. A Series of Lectures given at the Experimental Farm at Vincennes during 1867 and 1874 5. By M. Georges Ville. Translated and Edited by William Crookes, F.R.S. Second Edition, thoroughly revised. London: Longmans and Co.

M. Ville has come forward at a critical point in the career, not merely of English but of European agriculture. Rapid steam navigation and cheap land conveyance on both sides of the Atlantic have rendered it possible for the American producer of corn, cattle, cheese, &c., to compete with the British and the French farmer in their own markets. The question arises what is to be done? Taxes on the introduction of food from abroad can never be tolerated in a country where multitudes of the population, even at present prices, can scarcely earn a sufficiency of the common necessaries of life. We must therefore endeavour to secure larger returns from our own soil, so

as to conciliate the apparently conflicting interests of the country and the town, of the farmer and the artisan. How to effect this desirable consummation is the object of M. Ville's teachings. Taking his stand upon practical experiments conducted in numerous places, he declares that the European farmer need not fear American competition if he will give his crops plant food of the right kind, and in the right quantity in the form of chemical manures. If this is done, he shows by successful trials that wheat can be produced at a lower cost, hat the area of land at present devoted to grazing may be lessened without decreasing the supply of meat and dairy produce, and that the whole population, and consequently the country, may be more prosperous. In England we have come to a very different conclusion. Some of the oracles of the day advise the farmer to cease cultivating the land and to lay it down to "permanent pasture!" It must of course be admitted that in England we encounter certain disadvantages from which France is comparatively free. We enjoy less often a warm and dry summer. We have allowed the beds of our rivers to become silted up with refuse, so that a slightly increased rainfall sends their waters out over the adjoining lands in a destructive flood. But in spite of all these disadvantages, a practical farmer, whose pamphlet we had the pleasure of reviewing not very long ago, has shown us that wheat can be, and has been, grown at a profit, even during the last unfavourable years On the other hand, Mr. W. A. Gibbs has taught us how both hay and grain may be securely harvested in wet seasons. So that there is no occasion to say that the teachings of M. Ville can have for us especial interest. We can grow grain at a profit if we will only use the methods which Science offers to our hands. The author recommends chemical manures in preference to farmyard manure for several reasons. In the first place the former is the cheaper. The active principles in a dung-heap cost more per pound than do the same principles applied in the form of phosphate of lime, of Stassfurt salts, and of sulphate of ammonia or of Chilian saltpetre. This may perhaps astonish certain farmers of the old jog-trot school, who by dint of bad book-keeping, or sometimes by keeping no books at all, have come to the conclusion that farmyard manure costs little or nothing. Whence comes the fertilising matter contained in the dung of animals? An ox or a sheep cannot create nitrogen, phosphorus, or potash. All of these substances, which are to be found in its liquid and solid excrements, have been derived from its food. That food has been grown upon the farm. Now if we could restore to a plot of say 100 acres the excreta of all the animals, human or brute, which have been fed upon the produce of the same hundred acres, we should certainly keep up the fertility of this plot of land, though we could never increase it. But this complete restoration to the soil of all that has been taken from it is impossible. Cattle and wheat have been grown, and are eaten in our towns in the forms of meat and bread. But the excrements of the persons consuming them do not find their way back to the farm. They pass into the sewers, are there diluted with an excess of water, and after duly polluting our rivers, pass out to sea. It is therefore utterly idle to think that we can keep up the fertility of our land by merely returning to it about one-half of what has been taken from it. Yet this is what is practically hoped for by those who think that the fertility of a farm can be permanently kept up by means of farmyard manure alone.

Chemical manures have a further advantage beside that of cheapness. They can be varied in their quality just as is required by the wants of each crop and each soil. All these points M. Ville enforces clearly, illustrating his doctrines by actual experience. He does not proscribe farmyard manure. He protests merely against its being made the exclusive stay of the farmer, and shows how it may be adapted for particular purposes by the addition of the necessary chemicals.

So far, perhaps, the teachings of the author differ little from those of the majority of chemists who have made agriculture their especial study. But on certain important points he stands almost alone. It is generally supposed that plants derive their nitrogen from the soil and from the manure added or from ammonia and oxides of nitrogen present in the air. M. Ville, on the other hand, contends that certain plants, *e.g.*, peas, beans, clover, and lucern, are able to absorb and assimilate the free nitrogen of the atmosphere, and consequently do not require, and are not benefitted by, nitrogenous manures. Hence he further argues than an arable soil may be preserved in full fertility if we restore to it year by year one-half of the weight of nitrogen which has been removed by the crops. It must here be admitted that the full weight of experimental evidence is against M. Ville. Not a few skilful chemists have studied this point. Seeds have been sown in soils containing every requisite of plant-growth save nitrogen. They have been exposed to air from which all ammonia, ammoniacal salts, and nitrogen oxides had been carefully removed. But on analysing the crop no excess of nitrogen was found over and above that present in the seed. These experiments have been multiplied and repeated under different conditions, such as degrees of heat, moisture, speed of current of air to which the plants are exposed, but the results have been negative. The cultivation experiments of M. Ville as recorded seem indeed to support his theory, seeing that nitrogenous manures have in his hands proved themselves useless as applied to the crops above mentioned. On the other hand, Dr. Lawes finds that red clover, if cultivated year by year in a given plot of soil without the addition of any nitrogenous manure, does exhaust the soil of nitrogen. Or, to speak more guardedly, the nitrogen in the soil decreases when no plant save red clover has access to it.

Another peculiarity in the views of M. Ville is the exclusive weight he lays upon three mineral constituents—phosphoric acid, potash, and lime. He does not deny that the other mineral elements found in the ash of plants are necessary to their vigorous growth, but he considers that with all, save phosphoric acid, potash, and lime, "even the poorest soils are sufficiently supplied." Hence in all his formulæ for manures lime is invariably present in the form of gypsum, whilst magnesia is as invariably absent.

It is right here to admit that the universal applicability of gypsum—and, indeed, the general necessity for lime—is not confirmed by English experimentalists. So far from it, that a method for preparing soluble phosphate without the simultaneous production of gypsum is desired by many. M. Ville's experiments generally show a somewhat better result when his complete manure—ammonium sulphate, superphosphate, potassium sulphate, and gypsum—is used than when the gypsum ingredient is left out. But it must not be forgotten that in this latter case he uses dicalcic phosphate instead of the ordinary soluble phosphate,—a change which may easily produce a difference independent of the presence or absence of gypsum.

An exceedingly important point in M. Ville's treatise is his advice to decide on the capabilities and requirements of land by means of trial plots, one, *e.g.*, to be treated with farmyard manure in known proportion, a second with the complete or normal manure, others with manures each deficient in some one of his four leading principles, nitrogen, phosphate, potash, and lime, whilst a last plot is left unmanured. He throws out the suggestion that trial-plots on a small scale should be attached to elementary schools in rural districts, so that boys may be early impressed with the leading conditions of plant life.

Setting aside certain ideas which are at present not proven, M. Ville's work is of great value to all interested in agriculture, and deserves a careful, and wherever possible an experimental, study.

Deodorisation of Musk.—W. Wiesenthal.—A solution of quinine hydrochlorate in water acidulated with hydrochloric acid, entirely and quickly removes the odour of musk from any object.—*Chemiker Zeitung.*

CORRESPONDENCE.

THE ACTION OF WATER ON LEAD.

To the Editor of the Chemical News.

SIR,—In reading Mr. Allen's paper (CHEMICAL NEWS, vol. xlvi., p. 145), and arguing from the experimental results he published, I was led to a completely opposite conclusion to that which he attains, namely, that the presence of a trace of free sulphuric acid is advantageous in the case of soft waters coming in contact with lead pipes. The deductions and conclusions which led me to this result were as follows:—

That free sulphuric acid acts upon metallic lead.

That the amount of lead dissolved by sulphuric acid present in waters advances with the amount of acid added, but that the proportion of lead dissolved as compared with the amount of lead which the added acid is capable theoretically of dissolving advances at a much greater rate than the amount of acid added.

Thus, with regard to the experiments with natural Sheffield waters in which was a known quantity of acid, we find that in No. III. there were added 1·12 grains of free sulphuric acid per gallon. Now the amount of metallic lead which Mr. Allen finds to have been taken up into solution by this acid is 0·28 grain per gallon, whereas, theoretically, it should dissolve if the acid were saturated 2·898 grains; that is to say, that the acid took up just one-tenth of the theoretical amount. In the same way, in experiment No. IV., the acid added was 5·6 grains per gallon, the lead actually taken up was 4·9 grains per gallon, while the theoretical amount is 14·49; that is, the acid took up rather more than one-third of the theoretical amount.

From these two experiments, and also approximately from No. II., although the quantities are not given sufficiently exactly to form any accurate deduction, yet, speaking generally, it appears:—

I. That at least from 0·112 to 5·6 grains per gallon the greater the amount of acid added the greater is the amount of lead dissolved, and this is the conclusion Mr. Allen has drawn. But at the same time it also appears—

II. That even when the water has taken up the maximum amount of lead sulphate it can hold in solution the action of the acid will still continue, the extra sulphate being presumably in the state of suspension. And lastly—

III. That the less acid there is present the smaller fraction of that acid will be saturated in a given time.

Thus in No. III. the proportion saturated = $\frac{1}{10}$.
In No. IV. the proportion saturated = $\frac{1}{3}$.

The apparent anomaly in this third deduction may, I imagine, be partly explained in the case of lead pipes by considering that when a strongly acid water comes in contact with the lead a strong solution of lead salt is formed along the line of contact, and this solution, on account of its difference of density, sets up a current, thus continually enabling fresh acid to come into contact with the lead. This action being of course proportional to the strength of the acid, it follows that a stronger solution of acid—between the limits laid down—would have a greater fraction of its acid saturated with lead in a given time. In the case of leaden plates such as Mr. Allen used in his experiments, this action is probably accounted for by the different rates of diffusion, when the greater the difference in density between the two liquids the higher will be the rate of diffusion, from which the same conclusions may be drawn as in the case of the action on lead pipes. Therefore—within the limits prescribed—the less the amount of free sulphuric acid present in the water the less proportion of that acid is likely to be saturated with lead in a given time; and, conversely, the larger proportion of it will remain free, in the presence of which free acid neither the carbonate nor the oxide of lead can exist, and it is only by such prolonged contact that the whole of the free sulphuric acid becomes saturated—and Mr. Allen's experiments clearly prove that this is a long process—that any carbonate or oxide of lead can enter into solution.

Supposing, on the other hand, this natural soft water to be either neutral or alkaline, the action will be presumably as follows:—The oxide will in the first place be formed, and this being acted on by the available carbonic acid in the water, will be instantly converted into the almost insoluble neutral carbonate, which in the presence of excess of oxide of lead will become the all but absolutely insoluble basic carbonate of lead. This will immediately fall out of solution as such, leaving the water deprived of its carbonic acid and free to act in conjunction with its free oxygen on the metallic lead, thus forming the oxide, comparatively speaking, so extremely soluble.

This explanation is borne out by Mr. Allen's experiment with distilled water No. I., when he finds it to have taken up 7 grains of lead per gallon. Of the state in which these 7 grains of lead exist in the water apparently two views may be taken. First, that as Mr. Allen seems inclined to suppose, a considerable portion, say the whole, of the lead is in suspension as basic carbonate, which points to a very rapid action of this acid on lead; or, second, that only a portion of the lead is in suspension as carbonate, the remainder being present in solution as oxide, which view indicates that carbonic acid in water becomes rapidly saturated with lead, the water itself then proceeding to attack the lead by forming oxide, while, on the other hand, in the same time sulphuric acid taking even in the case of so large a quantity as 5·6 grains of free SO_3 per gallon is only able to become one-third saturated, and in smaller quantities not one-tenth.

From these considerations, then, it appears that sulphuric acid in minute traces prevents the action of soft waters from becoming so rapid as it would otherwise become if it were neutral or alkaline, which view is further supported by Mr. Allen's experiment No. I. with the natural Sheffield water, whose action he shows to have been so slow, as he states that this water was *slightly acid* rather than neutral. In fact the only experiment which Mr. Allen has made, which on the face of it appears to contradict this view of the case, is No. II. of the series made with distilled water, when it appears that 0·112 grains of free sulphuric acid were saturated with lead, and a further large quantity was taken up, as Mr. Allen states, in the form of suspended carbonate. But this also will go to confirm the view I uphold when it is remembered that, firstly, it is not a natural water and contains no salts in solution, which salts may very possibly retard the action of the free SO_3—and apparently do so judging from the experiments with natural waters; and, secondly, that this amount—0·112 grain of acid per gallon—may possibly fall below the amount with which this law holds good, as in experiment No. II. with natural waters, although only 0·112 grain of free acid were *added*, yet the water itself was previously acid.

Further, in considering the relative physiological effect of the carbonate and the sulphate of lead, the carbonate appears to be infinitely the more poisonous of the two, as it is very readily converted into extremely soluble salts by the action of the acids of the stomach. Thus, again, from this point of view it will appear preferable for the lead to exist as sulphate rather than as carbonate.

There is one other class of waters whose action on lead pipes it would be perhaps well to consider at this point, namely, hard waters. In this class of natural waters, as is well known, carbonate of lime exists in considerable quantities held in solution in the water by carbonic acid as calcic bicarbonate. This solution, then, of the bicarbonate coming in contact with the solution of oxide of lead formed by the joint action of the water and its free oxygen immediately forms a precipitate consisting of carbonates of lime and lead. From the very large amount of carbonic acid present in this available form, as also by the production of a double precipitate, it may be easily seen that it will be so copious as to rapidly coat the pipes, and

hus preserve them from further action. The large amount of salts in solution in this class of waters may also exercise a great effect in preventing the solution of any lead.

Lastly, the remarks which Mr. Allen makes on the question as to whether the free acid actually exists in the water in the state of sulphuric or hydrochloric acid appear to me to fall somewhat outside the enquiry, for he apparently admits that the prime origin of the free acid was the decomposition of iron sulphate into a basic salt with either the liberation of free acid or an acid salt, which acid he then considers to act on the metallic chlorides present in the water, thus liberating free hydrochloric. This may occur, but it must be borne in mind that the amount of lead dissolved by this free hydrochloric can be no more than an exact equivalent of the amount which the free sulphuric acid is capable of taking up; and, moreover, that (arguing in the same line which Mr. Allen adopts) this lead chloride is no sooner formed than it is converted into lead sulphate by the metallic sulphates. As to whether either the one or the other of these reactions *would* take place in solutions so dilute is a matter of speculation; but it will, however, be seen that, provided the original acid is sulphuric, it can have little to do with its power of taking up a definite quantity of lead, whether it sets free its equivalent of hydrochloric from chlorides present, or whether it acts directly on the lead itself.

The above deductions, based on Mr. Allen's experiments, appear to me to abundantly prove, and fully bear out, the contention of Dr. Tidy, Prof. Odling, and Mr. Crookes, that a trace of free sulphuric acid is advantageous in a soft moorland water, when its action on leaden pipes is considered.—I am, &c.,

ARNOLD PHILIP, A.R.S.M.

45, Tyrwhitt Road, St. John's, London,
September 6th, 1882.

IMPORTING ATMOSPHERIC AIR.

To the Editor of the Chemical News.

SIR,—Being a subscriber to your valuable paper, I read first only those articles relating to the business in which I am at present engaged (steel and iron). For this reason I was not aware until to-day of the little incident credited to Von Humboldt and Gay-Lussac (CHEMICAL NEWS, vol. xlv., p. 100).

Permit me to relate an occurrence that took place in the year 1867. In that year I was a student of the celebrated chemist Prof. Wurtz, at l'Ecole des Medicines à Paris. There were perhaps fifteen others studying at that time.

One of the students used a new French glass tube in making a combustion, claiming that it was superior to the Bohemian. Needing some glass tubes for my own use, I thought the best way to settle the dispute would be to try the Bohemian glass with the French. So I requested Dr. J. Bettendorf, of Bonn, to buy some Bohemian tubes for me. I asked him to cut them in two pieces, and melt the ends in a point, and to number the pieces and label them "Deutsche Luft." I did this to avoid trouble with the Custom-House officers.

There was no duty on articles used for scientific purposes, but it was sometimes very difficult to convince the Custom authorities that certain articles were intended for the uses of Science.

When the articles arrived I called at the Custom-House and paid *the two francs*, which the officer with a piercing smile demanded, feeling that I had paid the cent for tribute, while I was willing to spend in the defence of my rights millions,—if I had had them only!

Part of the tubes I divided among some of the students of Prof. Wurtz, and the balance I brought back to Germany with me. MM. Voigt and Gauthier, and perhaps M. Wurtz, will remember the occurrence.

Now, Sir, if the correspondent of the Berlin paper is sure that Alexander von Humboldt and Gay-Lussac did exactly the same harmless trick that I did, then really will I believe the old proverb "Nil novi sub sole."—I am, &c.,

HUGO BLANCK,
Chemist with Spang, Steel and Iron Co.,
Etna, Pa.

Sharpsburg, Pa.,
September 17th, 1882.

FORMATION OF OZONE.

To the Editor of the Chemical News.

SIR,—In reference to Mr. Kingzett's paper, which appeared in your last number, allow me to state that on presenting my views regarding the formation of ozone when phosphorus undergoes slow oxidation in a moist atmosphere, I did not think it necessary to introduce water into my equations as this would have in no way added to the clearness of the reactions, the only change which water undergoes being its combination with phosphorus pentoxide to form phosphoric acid, thus putting it out of the influence of further change, owing to the comparatively great stability of the latter compound.

Had pentoxide of phosphorus been an insoluble compound then I would have been obliged to take water into account, as in that case hydrogen dioxide would have been formed, and not ozone, thus:—

$$Zn + H_2O + (O-O) = Zn\,O + H_2O_2.$$

In the oxidation of phosphorus, hydrogen dioxide can result only in the presence of an excess of moisture, and then only in small quantity, as it is immediately decomposed by the ozone into water and oxygen, thus:—

$$H_2O_2 + (O-O-O) = H_2O + (O-O) + (O-O).$$

R. LAMONT.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 12, September 18, 1882.

Miasmatic Fevers.—M. d'Abbadie.—The author mentions that certain elephant hunters who frequent miasmatic districts of the Soudan, as a preservative, expose themselves daily to a fumigation with sulphur. The town of Zephyria, in the island of Milo, was populous as long as sulphur mines were worked in its immediate neighbourhood, but became deserted on the removal of this industry to the opposite side of the island. The desertion of the town was owing to the severe malarious fevers which became common. [If sulphur fumes are a prophylactic against zymotic disease it is possible that the coal smoke of England may have a certain sanitary value.]

Separation of Gallium.—Lecoq de Boisbaudran.—(See page 165.)

The Influence of Temperature on the Spectra of the Non-Metals.—D. Van Monckhoven.—The author has proved by numerous experiments that the so-called "high temperature spectra" of the non-metals can be produced at very low temperatures and *vice versa*. He takes a tube with four electrodes in the form of H, and filled with nitrogen, oxygen, or one of the gases or vapours giving two spectra; into this tube he causes to pass at the same time the currents of two induction-coils, the one with the interposition of a Leyden jar. Two superposed spectra are observed; the spectrum attributed to high temperatures (Leyden jar) and the spectrum of low temperatures (ordinary spark). In accordance with Plücker's hypothesis the gas should therefore have at the same

moment two distinct temperatures, which is inadmissible. The author ascribes the change of the spectra emitted by the non-metals to a peculiar vibratory state of their molecules, depending directly on the nature of the electricity employed.

The Action of Presence of Leaves of Zinc in Boilers, and a Process for avoiding Explosions.—M. Trève.—The author finds that a battery is formed by the iron and the zinc, which occasions a continuous decomposition of water. The oxygen combines with the zinc, and the zinc oxide combines with the fatty acids present in the feed-water, forming a zinc soap, which prevents the adhesion of saline matter to the sides and plates of the boiler. The hydrogen prevents the danger of explosion from the absence of gaseous matter, and consequent superheating. When a boiler has been kept for a considerable time with its fire banked up, the hot water is totally deprived of air, and on then raising the heat an explosion is possible. In such cases he recommends that a part of the water should be run off, and fresh water containing air introduced in its stead.]

Justus Liebig's Annalen der Chemie,
Band 213, Heft 3.

Influence of Mass upon Chemical Transformations.—James Morris.—In the first section of this dissertation the author has studied the action of barium chloride upon mixtures of potassium chromate and carbonate in aqueous solution. In the second section he examines in like manner the action of barium chloride upon mixtures of potassium sulphate and carbonate, also in aqueous solution. The results of the investigation are that in the reaction the mass relations of the potassium salts employed are decisive, both salts giving up so much of their acid to the precipitate that the proportion of the residual salts in the filtrate may be expressed by numbers which are almost constant. The changes in the composition of the precipitates proceed not *per saltum*, but continuously. A given addition of carbonate increases the carbonic acid in the precipitate, first slowly, then rapidly, and at last slowly again. In the simultaneous action of chromic acid and carbonic acid, the latter possesses at a boiling heat a much greater efficacy than at common temperatures, whilst in case of sulphuric and carbonic acids this property is less conspicuous. Whether an equal quantity of liquid is employed or not, has no marked influence upon the final product so long as the mass relations of the salts employed remain the same.

Researches on Uranium.—Clemens Zimmermann.—The author's main object has been to test the assumption of Mendelejeff that the atomic weight of uranium should be doubled, and be taken in round numbers as 240. This question he decides in the affirmative. Among his chief results are the following: Uranyl salts in sulphuric solution are reduced by zinc only to urano-salts, which can be most accurately determined by means of permanganate solution. Uranyl salts are converted by zinc and hydrochloric acid into an uranium sub-chloride, Ur_2Cl_6. It is distinguished by instability, and is identical with Peligot's sub chloride. The volumetric method of Margueritte, which depends on the oxidising action of permanganate, is not adapted for the determination of metallic salts in hydrochloric solution. A simple modification renders it very accurate in such cases, and opens up a wide field for the examination of the reduction-products of many metallic oxides. This modification is as follows: If to a solution of ferrous chloride containing hydrochloric acid there is added a manganous salt (sulphate or chloride), and it is then titrated with a permanganate solution of known strength, not the slightest odour of chlorine is perceptible, and the number of c.c. of the standard solution required for oxidising the ferrous salt corresponds exactly to the calculated number. The author prefers manganous sulphate and prepares the solution by dissolving 100 grms. of the salt in water, and diluting to about 500 c.c.; 20 c.c. of this solution are sufficient to render the titration of ferrous salts with permanganate absolutely accurate, even in presence of 50 c.c. free hydrochloric acid. A further result is that the sub-uranous oxides of Guyard are non-existent. The uranous and sub-uranous salts are distinguished by very characteristic absorption-spectra. This reaction of the uranous salts is not in the least interfered with by the presence of compounds of chromium iron, zinc, nickel, &c. 20 c.c. of a solution of uranyl sulphate, containing 0·01569 grm. UO_3 per c.c., were heated in a small flask with zinc and 20 c.c. dilute sulphuric acid till the green colour of the solution shows a complete reduction to uranous sulphate. If, during this process, the solution is observed with the spectroscope, there appears first a narrow absorption-band in the greenish yellow, which is quickly followed by others in the red, blue, and violet.

Non-Existence of Pentathionic Acid.—W. Spring.—The author concludes that the existence of pentathionic acid is not proved.

Determination and Separation of Antimony and Tin.—Dr. A. Weller.—Antimonic acid and antimonic oxide, and in like manner antimony penta- and tri-chloride, can be most easily distinguished from each other by their different behaviour with potassium iodide. The property of the former when in hydrochloric solution of separating two atoms iodine from potassium iodide for each atom of antimony can be used for the quantitative determination of antimony. In order to verify the method, weighed quantities of finely-pulverised pure metallic antimony were oxidised in a flask at a gentle heat with potassium chlorate and hydrochloric acid, and the excess of chlorine was expelled by strong heating. The solution of antimony penta-chloride thus obtained was introduced into the flask of Bunsen's chlorine distillation apparatus by means of hydrochloric water, considerably diluted, and mixed with a sufficiency of perfectly pure potassium iodide, avoiding too great an excess. The liberated iodine was distilled into dilute solution of potassium iodide, observing all the precautions laid down by Bunsen, and especially cooling the retort well in flowing water. When cold the distillate is titrated in the usual manner by means of very dilute sulphurous acid and an iodine solution of known strength. The distillation flask has the capacity of about 120 c.c. The distillation requires from five to ten minutes. Particularly important is the fact that stannic acid and stannic chloride in acid solutions do not decompose potassium iodide. This behaviour renders it possible to determine antimony in presence of tin, as in alloys, easily and accurately. The tin is calculated as difference.

Communications from the Chemical Laboratory of the University of Graz.—These consist of the continuation of a memoir by Karl Garzarolli-Thurnlackh on the action of zinc ethyl and zinc methyl upon chlorinised aldehyds.

Journal für Praktische Chemie.
New Series. Vol. xxv., No. 11.

Certain Derivatives of Isophthalic Acid.—Dr. Bruno Beyer.—The author gives an account of isophthalic acid, γ-mono-nitro-isophthalic acid and its salts, and its ethyl and methyl ethers, γ-mono-amido-isophthalic acid, its salts and ethers: γ-diazo-isophthalic acid, γ mono-chlor-isophthalic acid, its salts and ethyl-ether, and γ-mono-oxy-isophthalic acid. The principal results are that the mono-nitro-isophthalic acid produced by treating isophthalic acid with fuming nitric acid, belongs to the so-called γ-series, as is shown by its conversion into the oxy-acid of that series. This mono-nitro-isophthalic acid (melting-point 249°) crystallises with 1½ mols. water, dissolves in 685 parts water at 15°, and in 1·23 parts at 99°. Its methyl-ether melts at 121·5°, and its ethyl-ether

at 83·5°. The γ-mono-amido-isophthalic acid crystallises with 2 mols. water; its aqueous solution is coloured an intense reddish brown by ferric chloride. It dissolves in 962 parts of water at 15°, and in 108·2 parts at 99°. Its ethyl-ether melts at 118°, and its methyl-ether at 176°. By the action of nitrous acid in the cold, the amido-acid passes into a well characterised diazo-compound, which yields γ-oxy-isophthalic acid on decomposition with water.

The Solutions which Salicylic Acid forms with Water.—Wladimisi Alexeew.—At temperatures between 63° and 90·5° salicylic acid and water form three kinds of solutions. 1. Solution of water in salicylic acid; 2. Solution of salicylic acid in water, which on cooling deposits the liquid acid; 3. Solution of salicylic acid in water, which on cooling deposits the acid in crystals. The two latter are isomeric.

Worthiness and Appreciation: Reply to the Attack of H. E. Drechsel.—J. L. W. Thudichum.—Not capable of useful abstraction.

Two Anhydrides of Para-oxy-benzoic Acid.—A. Klepl.—If para-oxy-benzoic acid is distilled at a moderate heat, and if the process is interrupted as soon as the residues solidifies, there remains a mixture of two anhydrides of the acid, which can be separated by boiling in absolute alcohol, in which the more abundant is insoluble. The author is engaged with the examination of these bodies.

A Solution of Anhydrous Copper Sulphate in Methylic Alcohol.—A. Klepl.—Absolute methyl alcohol dissolves the amorphous anhydrous sulphate, but not that which is rendered crystalline by taking up water. Ethyl alcohol does not possess this property.

Isomerism of Cuprous Sulphite.—M. Etard.—From the *Comptes Rendus*.

MISCELLANEOUS.

College of Agriculture, Downton, Salisbury.—Professor of Chemistry, J. M. H. Munro, D.Sc., F.C.S. During the winter session, courses of lectures are delivered on chemical physics, inorganic chemistry, organic chemistry, and agricultural chemistry. The laboratory is open daily for agricultural investigations, and classes are held in elementary practical chemistry, qualitative analysis, and the quantitative analysis of soils, manures, agricultural products, water, &c.

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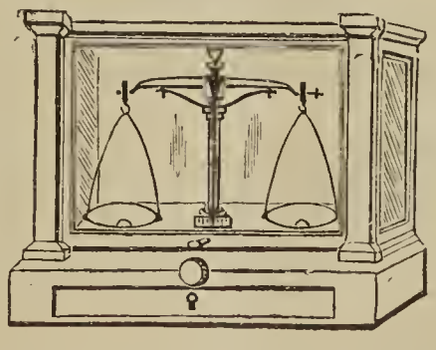

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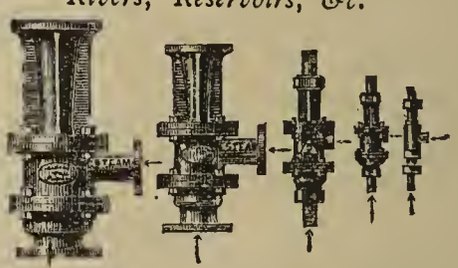

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THE CHEMICAL NEWS.

VOL. XLVI. No. 1195.

THE ESTIMATION OF DEXTROSE, MALTOSE, AND DEXTRINE IN AMYLOSE (STARCH SUGAR).

By HARVEY W. WILEY,
Lafayette, Indiana.

IN a paper read at the Cincinnati Meeting of the American Association for the Advancement of Science,* I gave a brief outline of some of the more important methods which have been proposed for the analysis of amylose.

In closing that paper I said:—"From a very extended series of analyses I will say that there is no method known which will give reliable numbers for the percentage of the different constituents. I propose to attempt the accomplishment of this very desirable result by first polarising the solution, treating it with a reducible reagent, and repolarising the residue."

Since that time I have succeeded in carrying out this plan with results which are sufficiently satisfactory to justify me in making them public.

Samples.

The amyloses which I have used were those of commerce, and were manufactured in widely separated localities. They were subjected to no process of purification, and were obtained in the open market and from the manufacturers. They were such as are usually employed in the adulteration of sugars and syrups.

The Process.

(1.) Ten grammes of the samples, undried, were dissolved in water, the volume made up to 1000 c.c., and used for the reduction of the standard Fehling's solution.

(2.) Ten grammes were dissolved in water, made up to 100 c.c., and polarised in 200 m.m. tube.†

(3.) Ten c.c. of (2) were treated with an excess of the mercuric cyanide solution (described further on) and boiled. Hydrochloric acid (strong) was then added in slight excess, and, after cooling, the volume made up to 50 c.c.

(4.) The above was next polarised in a 500 m.m. tube, and the angular rotation multiplied by two.

Theory of the Process.

(1.) The first reduction of Fehling's solution gives the total percentage of reducing matter, viz., dextrose with a reducing value of 100, and maltose with a like value of 62.

(2.) The first polarisation gives the apparent specific rotatory power due to all the optically active bodies present, viz., dextrose = 52, maltose = 139, and dextrin = 193.

(3.) The second reduction (by mercuric cyanide) leaves in the solution as optically active the dextrin alone.

(4.) The second polarisation gives the rotatory power of dextrine only.

With these points determined, all the data necessary to the calculation of the percentages of the three substances are at hand.

The Manipulation.

(1.) It is not advisable to take more than 10 g. in 1000 c.c. for treatment with the copper solution. From 10 to 20 c.c. of this will reduce 10 c.c. of the copper.

The end of the reaction I determine, in all cases, by filtering a drop or two into a white dish containing a little solution of ferrocyanide of potassium and acetic acid. Three closely agreeing determinations are made, and the mean of these taken as the correct result.

(2.) In polarisation I find 10 g. in 100 c.c. to be a convenient quantity. If a solid amylose is to be examined the solution must be heated to 100° for some time to destroy bi-rotation. For my optical work I use the large *pènombre* instrument made by Laurent, which has been adopted for use in all the sugar work done by the French Government.

(3.) A convenient strength for the mercuric cyanide solution is 120 g. $Hg(CN)_2$, and the same amount of stick NaOH per litre. It is not necessary to standardise the solution. If a precipitate is formed in mixing the cyanide solution with the alkali, filter through asbestos before using. 20 c.c. of the solution will be found sufficient for amyloses with less than 65 per cent reducing matter. When more than this is present use 25 c.c.

In all cases a slight excess of cyanide must be used. Test by holding filtering paper with a little of the solution on it over fuming HCl, and afterwards over ammonium sulphide. A 50 c.c. graduated flask is used. In boiling care must be taken that the liquid is not thrown out. Two or three minutes boiling will be found sufficient. On application of heat the liquid turns reddish brown. When HCl is added this colouration disappears. In no case have I found it necessary to use animal char or lead acetate to fit the liquid for the observation tube. Since the volume of the liquid has been increased during the process from 10 to 50 c.c., and the tube of observation is only two-and-a-half times as long as the first one, it becomes necessary to multiply the reading of the instrument by two in order to subject it to the same conditions as the first polarisation. This gives the polarisation due to *dextrin* alone.

Calculations.

(1.) The first reduction gives the reducing per cent of the dextrose d + that of the maltose m. Since maltose, however, has a reducing power as compared with dextrose of only 0·62; we have the equation—

$$R = d + 0{\cdot}62\,m \quad (1)$$

(2.) The first polarisation gives the rotation due to the dextrose, maltose, and dextrin. From this the apparent specific rotatory power is easily calculated.* This gives the equation—

$$P = 52\,d + 139\,m + 193\,d' \quad (2).$$

(3.) The second polarisation gives the dextrin rotation power, and is expressed—

$$P' = 193\,d' \quad (3),$$

from which the value of d' is easily calculated.

(4.) To find d and m: subtract equation (3) from (2). This gives—

$$P - P' = 52\,d + 139\,m \quad (4).$$

Multiply (1) by 52, and subtract from (4).

$$P - P' - 52R = 106{\cdot}76\,m \quad (5).$$

Whence—

$$m = P - P' - 52\,R \div 106{\cdot}76 \quad (6)$$

and $$d = R - 0{\cdot}62\,m \quad (7)$$

and $$d' = P' \div 193 \quad (8)$$

Illustration.

Sample of solid amylose made by Peoria Grape Sugar Company.

10 g. in 100 c.c. polarised 21·29°. Whence P = 106·45. Percentage of reducing matter R = 40·32.

Polarised after treatment with $Hg(CN)_2$, 13·4°. Whence P' = 67.

Substituting these values in the several equations—

* *Science*, vol. ii., No. 66, pp. 464—466.

† To save one weighing the solution (2) was first made, and 10 c.c. of it made up to 100 c.c. for No (1).

* *Proceedings A.A.A.S.*, Boston Meeting, 1880, p. 309.

TABLE I.

	I.	II.	III.	IV.	V.	VI.	VII.
Per cent reducing matter	40·32	76·33	72·83	66·67	67·57	37·88	41·84
Total rotation	21·19°	9·85°	9·11°	10·19°	10·27°	22·95°	20·60°
After treatment with $Hg(CN)_2$ ..	13·4°	1·38°	1·04°	2·36°	2·39°	17·46°	12·45°
Due to dextrose and maltose	7·89°	8·47°	8·07°	7·83°	7·88°	5·49°	8·15°
Specific gravity 10 g. in 100 c.c. ..	1·030136	—	—	1·03198	1·03107	1·03162	1·02938
Per cent solids from sp. gr.*	78·28	—	—	83·07	80·70	82·13	76·57
Per cent solids determined directly and optically active†	81·62	80·85	76·41	74·38	75·25	85·87	80·85
per cent of ash	0·19	0·57	0·23	0·57	0 63	0·33	0·24
per cent of water	16·26	9·43	15·75	16·24	14·94	16·82	18·31

NOTE.—No. 1 from Peoria Grape Sugar Co.; No. 2, Buffalo; No. 3, Freeport, Ill.; Nos. 4 and 5, American Grape Sugar Co., Buffalo; No. 6, ditto; No. 7, Rockford Grape Sugar Co., Rockford, Ill. Nos. 1, 2, 3, 4, and 5 were solids: Nos. 6 and 7 liquids.

* Allen's "Commercial Organic Analysis," vol. ii, p. 296. † Sum of dextrose, maltose, and dextrin.

TABLE II.

	I.	II.	III.	IV.	V.	VI.	VII.
Per cent dextrose	29·59	74·78	71·40	64·07	65·15	33·38	30·81
Per cent maltose	17·31	2·49	2·32	4·20	3·90	7·26	17·79
Per cent dextrin	34·72	3·58	2·69	6·11	6·20	45·24	32·25

TABLE III.

	I.	II.	III.	IV.	V.	VI.	VII.
Dextrose—Direct	29·59	74·78	71·40	64·07	65·15	33·38	30·81
,, Calculated ..	29·58	73·41	71·38	64·05	65·01	33·38	30·80
Maltose—Direct	17·31	2·49	2·32	4·20	3·90	7·26	17·79
,, Calculated ..	17·27	2·20	2·34	4·22	4·13	7·27	17·81
Dextrin—Direct	34·72	3·58	2·69	6·11	6·20	45·24	32·25
,, Calculated ..	34·70	5·24	2·69	6·11	6·11	45·23	32·24

(1) $0{\cdot}4032 = d + 0{\cdot}62\,m$
(2) $106{\cdot}45 = 52\,d + 139\,m + 193\,d'$
(3) $67 = 193\,d'$
(4) $39{\cdot}45 = 52\,d + 139\,m$
(5) $106{\cdot}45 - 67 - (52 \times 0{\cdot}4032) = 106{\cdot}76\,m.$
(6) $m = 0{\cdot}1731 = 17{\cdot}31$ per cent
(7) $d = 0{\cdot}2959 = 29{\cdot}59$,,
(8) $d' = 0{\cdot}3472 = 34{\cdot}72$,,
Sum of m, d, and d' = 81·62 ,,
Water = 16·26 ,,
Ash = 0·19 ,,
Sum = 98·07 ,,
Inactive = 1·93 ,,

Table I. shows the numbers obtained in seven analyses of different samples. These samples show the widest differences in composition from an extremely low conversion like confectioners' glucose, No. 6, to a very high conversion like No. 2.

Calculations from the above data give the percentages shown in Table II. of dextrose, maltose, and dextrin.

The result in No. 6 is a remarkable one. The sum of the three per cents, plus H_2O, is more than 100. This doubtless arises from the presence of a variety of dextrin or soluble starch with a rotatory power different from 193. If the percentages of dextrose, maltose, and dextrin are calculated from the specific gravity of the solution,* the most contradictory results are obtained. In most cases the percentage of maltose becomes a negative quantity of considerable magnitude, and the other percentages are in like manner distorted. This method, which heretofore has been regarded as the best one, is valueless for showing the actual composition of the starch sugars of commerce. Even if no other solids were present in the solution except the three in question, a slight error in specific gravity determinations would make a wide difference in the results. But the amount of other solids, optically inactive, present in a commercial starch-sugar may be (as shown) as great as 10 per cent.

* Allen, *op. cit.*, pp. 346-7.

For convenience I have placed the method of calculation, as given by Allen, in the form of the following

Rule

Multiply the percentage of reducing matter in sample by 52. Subtract per cent reducing matter from total solids (determined from sp. gr.), less ash, and multiply remainder by 193. Take the sum of the two products, and subtract from apparent sp. rotatory power. Divide the remainder by 33·42, and multiply by 100 for per cent of maltose.* Multiply per cent maltose by 0·62, and subtract from reducing power for per cent dextrose. Find dextrin by difference.

If the sum of the optically active solids determined in the direct way is taken as a basis of calculation, and the above rule applied, it will afford a check on the direct method, which will prove a valuable aid in reaching reliable results.

In Table III. are shown the results obtained by this method compared with those given by direct determination.

The numbers show that the method of direct determination is practically reliable. For if the results it gives were far from the truth, the theoretical calculations founded thereon would vary widely from the numbers obtained. Except in No. 2, however, this disagreement does not occur.

In No. 2 the variation is too great to pass unnoticed. In such a case the error is probably some fault of the first determination. Where the variation is as great as in No. 2 a new analysis should be made.

I do not know any method for determining such bodies as soluble starch, or varieties of dextrin as such.

Enough has been given to show that the method of direct determination by double reduction and polarisation is the only reliable one for estimating dextrose, maltose, and dextrin in commercial amyloses, where these, as is generally the case, are the only optically active bodies

* Let R, T, and P represent the amounts of reducing matter, total solids, and specific rotatory power respectively. Then—

$$m = P - [(T - R)\,193 + 52\,R] \div 33{\cdot}42.$$

present in any notable quantity. Practically the process will prove of great benefit to starch-sugar manufacturers, brewers, and distillers, and in all other cases where the exact constitution of these sugars is an important factor in their value.

The numbers given by this new process will vary with the numbers which represent the specific rotatory of the several substances to be determined, and also with the number which expresses the relative reducing power of maltose. If any or all of these numbers should undergo revision, it would only affect the results and not the method employed. It must be also understood that the method itself is based on the assumption that both dextrose and maltose, when treated to saturation with reducible solutions like mercuric cyanide, yield decomposition products which are optically inactive.

My experiments, so far, serve to confirm this assumption, although my inability to procure perfectly pure specimens of dextrin and maltose has prevented me from being able to communicate any definite information at the present time.

I will therefore reserve this part of the subject for a future report.

THE REACTIONS OF THE MEXICAN AMALGAMATION PROCESS.

At the suggestion of Dr. Percy, Professor Huntington, of King's College, London, made a series of experiments in 1879, on the reactions in the Mexican amalgamation process. It will be remembered that Dr. Rammelsberg, of Berlin, has also investigated the same subject. The following are some of the main points investigated :—

1. Mercury worked up with sulphide of silver, chloride of sodium, sand, and water, extracted about $\frac{7}{8}$ of the silver present, and three times as much as when chloride of sodium was absent. The presence of oxide of iron causes loss of mercury when the mixture contains chloride of sodium, owing to ferric chloride being formed, which is reduced to ferrous chloride by the mercury, with formation of calomel. A very little oxide of iron has a very marked effect, as the ferrous chloride, as fast as formed, reoxidises, contact with the air, to ferric chloride, and so on.

2. When, in addition to the chloride of sodium, the mixture was made up with sulphate of copper, which would produce chloride of copper by double decomposition, rather less silver was obtained, and the loss of mercury was greater. However, on substituting the mineral proustite (silver 65·5, arsenic 15·1, sulphur 19·4) for the artificial sulphide of silver, twice as much silver was extracted by the mercury when the mixture contained chloride of copper. The decomposition of the sulphide of silver is very imperfect, unless the mixture be frequently and thoroughly agitated.

3. Sulphide of zinc, in the presence of cupric chloride, causes the formation of sulphide of copper and chloride of zinc. It is well known that ores containing blende amalgamate badly.

4. A number of experiments were made to establish the action of cupric and cuprous chlorides on sulphide of silver. The generally-accepted explanation of the action of the chloride of copper in the Mexican amalgamation process is embodied in the following equations :—

$$1.\ Ag_2S + 2CuCl_2 = 2AgCl + Cu_2Cl_2 + S;$$
$$2.\ Ag_2S + Cu_2Cl_2 = 2AgCl + Cu_2S.$$

In the experiments made by Professor Huntington, it is shown that the liberation of the sulphur is entirely due to a secondary reaction, which takes place only to a limited extent. It may be represented as follows :—

Primary.

$$Ag_2S + CuCl_2 = 2AgCl + CuS;$$

Secondary.

$$CuS + CuCl_2 = Cu_2Cl_2 + S.$$

The secondary reaction takes place *pari passu* with the primary, at the moment double decomposition is occurring between the cupric chloride and the sulphide of silver, and is brought about by the copper of the chloride concerned in the reaction reducing to a lower chloride a further quantity of cupric chloride, in preference to combining with the sulphur of the sulphide of silver ; so that, in the result, chloride of silver, cuprous chloride, and free sulphur are produced. The experiments, as a whole, lead to the conclusion that the amount of cuprous chloride formed and sulphur set free is directly dependent on (*a*) the strength and quantity of a solvent for cuprous chloride present, such as NaCl and $CuCl_2$, (*b*) the temperature, (*c*) the presence of air. The secondary reaction is limited by the power of the solution to dissolve cuprous chloride. Obviously, if the cuprous chloride in solution can by any means be removed, the solvent power of the solution will be to a certain extent renovated. The action of air in facilitating the secondary reaction is therefore due to its converting the cuprous chloride into insoluble oxychloride, according to the equation—

$$3Cu_2Cl + 3H_2O + 3O = 3CuO.CuCl_2.3H_2O + 2CuCl_2.$$

5. In the course of these experiments, it was found that, when sulphide of silver is treated with a strong solution of cupric chloride at a high temperature (boiling), in a stout closed bottle, cuprous chloride and free sulphur are formed in large quantities. If the heating be continued for some time, all the free sulphur disappears, and sulphuric acid is formed. Under similar circumstances, sulphide of copper strongly heated with cupric chloride, air being excluded, yielded sulphate of copper and cuprous chloride, no free sulphur being formed. Sulphur, strongly heated in a hermetically-sealed tube with water, produced sulphuretted hydrogen, but no sulphuric acid. When a 300 per cent solution of cupric chloride was similarly heated with sulphur, cuprous chloride and sulphate of copper were formed. The following equations explain what takes place :—

$$S + H_2O = H_2S + O.$$
$$H_2S + CuCl_2 = CuS + 2HCl;$$
$$CuS + 4O = CuSO_4.$$

Also, $CuS + CuCl_2 = Cu_2Cl_2 + S.$

6. The next point investigated was the action of cuprous chloride, dissolved in a solution of chloride of sodium, on sulphide of silver. This is a case of simple double decomposition, represesented by the formula—

$$Ag_2S + Cu_2Cl_2 = 2AgCl + Cu_2S.$$

A great many erroneous statements have been made by Malaguti and Durocher, and by others, as to the action of cuprous chlorides on mixtures containing sulphide of silver. They say that silver is liberated in the metallic state. On this supposition they have built up various theories relating to amalgamation processes and to geological phenomena. These errors have arisen through their having employed ammonia as a reagent in the investigation of the action of Cu_2Cl_2 on Ag_2S. Ammonia being a solvent for chloride of silver, they thought that if the latter were formed by the action of cuprous chloride on sulphide of silver, it could be dissolved out from the sulphide of copper by ammonia, and then detected by precipitation in the ordinary way. But when ammonia is added to a mixture of AgCl and Cu_2S, it causes double decomposition to take place, Cu_2Cl_2 being re-formed ; and $Cu_2Cl_2 + AgCl$, in the presence of ammonia, react upon one another with the formation of $CuCl_2$ and metallic silver. Thus :—

Primary Reaction.

$$2AgCl + Cu_2S + NH_3 = Ag_2S + Cu_2Cl_2.NH_3.$$

Secondary Reaction.

$$2AgCl + Cu_2Cl_2.NH_3 = Ag_2 + CuCl_2.NH_3.$$

Though, as a matter of fact, Malaguti and Durocher did not understand the results of their experiments, Rammelsberg's exclamation, "Did the French chemists not know that silver and cupric chloride can not exist together ?" is

not warranted, as under the conditions just stated they can. It was also found that "reversal" takes place when a mixture of chloride of silver and sulphide of copper is treated with water or chloride of sodium solution. No secondary reaction, liberating silver, however, takes place.

It follows from the foregoing that, in order to bring about double decomposition between sulphide of silver and chloride of copper, the chloride of copper solution must be maintained at a certain strength, otherwise the reaction will cease, and any thing which caused the solution to be still further diluted would undo a proportionate amount of the work already done.

ON THE PROPERTIES OF PURE METALLIC ALUMINUM.

By J. W. MALLET.

IN view of the marked effect upon the properties of the individual metals, which is often produced by the presence of even very small quantities of foreign substances, metallic or non-metallic, it is very desirable that when really pure specimens can be had, prepared and tested with unusual care, their properties shall be noted and recorded. Comparatively few of the metals have probably been procured and examined in a state of the highest attainable purity, and comparatively few chemists have learned by personal experience how very difficult it is to get rid of the last detectable traces of foreign matter. This difficulty is especially great in the case of those metals least easily reduced to the metallic state, among which may be counted aluminum.

The writer, having expended much time and labour upon obtaining pure metallic aluminum to be used in his work,* on the atomic weight of this element, succeeded in preparing enough for that purpose, and incidentally noted the following facts in regard to the metal—not forming a complete description of all its properties, physical and chemical—but yet deserving, perhaps, of being placed on record.

The crude (commercial) aluminum, used as the source of the pure metal, was found to contain :

Aluminum (by difference)	96·89
Iron	1·84
Copper	trace
Silicon	1·27
	100·00

This was converted into bromide by treatment with liquid bromine, observing the precautions described in the paper (in *Phil. Trans.*) above referred to. A large quantity of the aluminum bromide—more than two kilogrammes altogether—was purified by careful fractional distillation, with due regulation of temperature, repeated a number of times, until the product was perfectly colourless, and on solution in water gave no evidence of the presence of impurities, which were searchingly tested for. The reduction of the metal from this purified bromide was accomplished, but with much difficulty and great loss, by heating with pure sodium in a crucible made of, or lined with, a mixture of purified and dry alumina and sodium aluminate. The large globules of aluminum obtained were severally re-fused before the blowpipe on a support of alumina, and were then exposed for a short time to the action of hydrochloric acid on the surface, well washed with water, and dried. On solution of portions of the globules in pure hydrochloric acid, careful testing failed to show the presence of any of the impurities which might have been taken up from the materials and apparatus used. The entire absence of sodium was specially verified.

The colour of this pure aluminum was perceptibly whiter than that of the commercial metal—on a cut surface very nearly pure tin-white, without bluish tinge, so far as could be judged from the small pieces examined. The lustre, too, was very much that of tin in a fresh, untarnished condition.

The metal was distinctly softer than before purification. Hence its fracture was not easily observed, but seemed to be very fine grained, with some appearance of fibrous silkiness. The malleability was undoubtedly improved, the metal yielding easily to the hammer, and bearing distortion well by flattening in two or three directions without cracking. It seemed to be sensibly less hardened by hammering than the ordinary metal of commerce.

The specific gravity was carefully determined at 4° C., and the mean of three closely concordant experimental results gave the number 2·583 as referred to water at the same temperature.

Hence the "atomic" volume = 10·45, near that of gold (10·19, if the sp. gr. be taken as 19·295, the value found by Roberts for the large trial-plate of fine gold of the English mint), and standing to that of iron nearly as 3:2 (the at. vol. of the latter being 7·11, if the sp. gr. be taken = 7·88, as found by Caron for pure iron fused in the oxy-hydrogen flame).

The specific heat was determined by means of Bunsen's ice calorimeter and found to be = 0·2253 as a mean for the range of temperature 0°—100° C., a number rather higher than those obtained by Regnault and Kopp. This number multiplied by 27·02, the atomic weight found in the experiments for which the metal was prepared, gives the product 6·09 as the atomic heat.

The quantity of pure material at command was not sufficient to allow of any determination of the conductivity, though this would be an interesting point to examine, in view of the high conducting power of the commercial metal, and the probability that the value would be notably raised by the removal of impurities. An imperfect attempt was made to measure the expansion by change of temperature, using for the purpose determinations of specific gravity in water at widely different temperatures, and correcting for expansion of water and glass, but the quantity of material was too small to make the result trustworthy.

It was also attempted to estimate roughly the fusibility, by placing equally heavy beads of the pure and the commercial aluminum in front of a fine blowpipe jet, this jet being fixed in position and fed with air by a steady water blast. From the difference of distance at which the beads could be just fused it seemed probable that the pure metal was a little less fusible than that of commercial character.

Under the same conditions of heating the former seemed to oxidise on the surface with rather more ease than the latter. On the other hand, the pure metal seemed to present perceptibly greater resistance to the prolonged action of solvents—acids and alkalies—than the impure.

University of Virginia,
July 15, 1882.

* *Philosophical Transactions*, Part III., 1880.

Indexing Chemical Literature.—The proposition made by Dr. H. Carrington Bolton at the Montreal meeting of the American Association for the Advancement of Science, for organised effort in the preparation of indexes to the elementary substances on a uniform plan,* was favourably received by the members of the Chemical Section. At the meeting held on August 25th, the following Committee was appointed "to devise and inaugurate a plan for the proper indexing of the literature of the chemical elements, said committee to have full power to secure the co-operation of volunteers, and to report at the meeting of the Chemical Section in 1883." Dr. H. C. Bolton, of Hartford, Chairman; Prof. Ira Remsen, of Baltimore; Prof. F. W. Clarke, of Cincinnati; Prof. A. R. Leeds, of Hoboken; Dr. A. A. Julien, of New York.

* See CHEMICAL NEWS, vol. xlvi., p. 167.

ON THE FIXATION OF CERTAIN ARTIFICIAL COLOURING MATTERS BY MEANS OF METALLIC MORDANTS.

By M. HORACE KŒCHLIN.

The colouring matters which the author has tried are phloxine, ponceau 3R, primerose, magenta, saffraine, eosine, picric acid, orange No. 2, phosphine, methylene and diphenylamine blues, extract of indigo, orchil, Poirrier's violet, roccelline, binitronaphthol, Bismarck brown, neutral red, induline, and Coupier's grey. The mordants were aluminium, chromium, magnesium, and calcium acetates, singly and mixed.

Phloxine gave a bad result with pure aluminium acetate, a brilliant cherry red with aluminium and magnesium acetates, a bright rose with aluminium and calcium acetates, and an amaranth with chromium and magnesium acetates.

Ponceau 3R gives a bright red with aluminium and magnesium acetates, and a red, imitating madder red, with chromium and magnesium acetates.

Primerose gives with chromium acetate a rather dull red of a violet cast, which bears soaping.

Magenta.—The best result is obtained with chromium acetate, but the colour has little merit.

Saffranine.—Chromium acetate gives the best colours, but they are of no value.

Eosine gives with chromium acetate a deep red; with aluminium acetate the colour is quite fugitive.

Picric Acid gives with mixed aluminium and magnesium acetates a yellow which does not bear soaping. Nothing with aluminium acetate alone or with chromium acetate.

Orange No. 2 requires a mixture of magnesium and chromium acetates; the latter alone gives a brownish cast, and the former alone is not fast.

Phosphine with aluminium acetate dyes a nankeen yellow which bears boiling soap-lyes.

Blue 5B gives a very deep blue with chromium acetate; with a mixture of magnesium acetate the colour is less intense, but then bears soaping. *Methylene Blue* yields a bad result.

Diphenylamine Blue gives a deep shade with chromium acetate, but does not bear soaping without an admixture of magnesium and aluminium acetates.

Extract of Indigo requires aluminium acetate, but the shade is not fast.

Malachite Green gives the purest shades with a mixture of aluminium and magnesium acetates, but deeper colours are obtained with chromium and magnesium acetates.

Cæruleine, Poirrier's Violet, and Orchil work best with chromium acetate.

Roccelline gives a brick-red, which does not bear soap with aluminium acetate, or with a mixture of chromium and magnesium acetates.

Binitronaphthol yields no colour.

Bismarck Brown gives a good colour with chromium acetate.

Coupier's Grey requires chromium acetate or a mixture of chromium and magnesium acetates.

Induline dyes under the same conditions as Coupier's Grey.

Many of these colouring matters require the use of double mordants in order to produce the fastest colours. In this respect they agree with the madder dyes, which, however, none of them equal in fastness. The origin of these compound mordants may be traced back to an observation made about the end of the last century by Michael Hausman, who, after having dyed fast madder reds in Normandy could not succeed in producing reds of this quality with the waters of the Vosges, which are free from calcareous matter. Hausman soon remedied this inconvenience by introducing the use of chalk. This addition was the more necessary as he was dyeing with Dutch and Alsatian madders, which are free from lime and very acid. Thus the chalk was at first supposed to act merely as a neutraliser. Persoz, H. Schlumberger, and D. Kœchlin, brought out the theory of the assimilation of lime to alumina in presence of the colouring principles of madder. These chemists analysed the tissues after every operation of madder-dyeing and proved that the alumina remained in them finally in the state of calcium aluminate, and that the case was similar with iron mordants, and other protoxides, such as those of magnesium, tin, and zinc, &c.

Previous to these researches M. D. Kœchlin called attention to the curious resistance which these compound mordants acquire, and he cited the instance of an aluminous mordant printed upon cloth upon which tin mordants had been previously applied. The cloth, which had been boiled in sours to strip it, took up again the colouring matter, but only where the two mordants were superimposed.

There was then a process known as China Blue, which depended upon these properties. It was indigo blue mixed with chloride of tin. This blue was alternately steeped in lime and copperas; it was slightly soured and preserved its tin. But this base was not sufficient to give a bright weld yellow without a previous passage in alumina. The tin was thus charged with alumina, and could then fix an intense and fast green colour.

To make up calcareous mordants it is necessary to mix a salt of lime with one of alumina and precipitate with sodium carbonate. The mordants of lime and of sesquioxides have not merely more solidity, but the property of giving shades different from those obtained with the sesquioxides alone.

A preparation with stannate is often employed in dyeing as a means of fixing alum or some other sesqui-salt, mordants which in turn may again be charged with protoxides. Tin therefore plays the part of a mordant for alumina in cases which do not require that the mordants should be incapable of being attacked by alkalies.

Compound mordants have a greater resisting power both as regards acids and alkalies, and are therefore suitable for colours which exert one or other of these reactions.—*Moniteur Scientifique* (1882, p. 808).

PYROLOGICAL NOTES.

By Lieut-Colonel W. A. ROSS, late R.A.

I. Introductory, and on a New Blowpipe Reagent.

The science to which I have ventured to apply the term "Pyrology," undoubtedly received the chief attention of European chemists and physicists until the time of the great Scheele. The extraordinary efforts and discoveries of that genius, and after him, of Klaproth, brought inorganic chemical analysis by means of water solutions of acids and alkalies into general favour and practice; and the immense and accurate quantitative results obtained by Klaproth (who was evidently, however, educated in the "docimastic" or dry-method school of Pott, of Berlin, for the 50 preliminary pages of his "Analytical Essays" are devoted to the behaviour of "Stones and Earths in the Fire of a Porcelain Furnace") had the final effect of driving dry methods of analysis out of favour, and almost out of sight; in spite of the wonderful discovery of the chemical blowpipe by the Swede, Von Schwabe,* and of its excellent application by Von Engeström, Bergmann, Gahn, Berzelius, Griffin, and Plattner, afterwards, though with defective reagents. Now, no one can for a moment dispute that this succession of chemical events was, in the main, as it ought to have been; and that the wonderful precision, beauty, accuracy, and delicacy of inorganic analysis in the humid way, has only received as it ought

* This word, the ordinary English spelling of which gives it quite a vulgar sound, should be pronounced like the English word arbour—"Shvarbour."

to have done the chief attention of European chemical philosophers for nearly a hundred years.

But perfection has been apparently attained on this side of analytical chemistry. The genius of Dalton has introduced the subject to mathematics, or mathematics to it; and inorganic chemistry now-a-days is to be considered more as a matter of algebraic rule than of experimental investigation, of abstract orthodoxy than of empiric discovery, of deductive than of inductive consideration.

This being so, if any English, or German, or French, or Russian, or American chemist—if even any ordinary educated individual with so little pretension to chemical knowledge as myself—can *prove* to the satisfaction of European chemical philosophers, that there is another side of inorganic analytical chemistry, almost entirely uninvestigated, which can be applied to and united with spectroscopy and microscopy, until it also can be made to progress speedily towards perfection and mathematical accuracy,—which will not in the least interfere with, but only supplement the perfection attained in established chemical and physical theories,—which can evidently investigate and detect the hiding places of the most minute traces of combined inorganic matter in a new and unexpected manner, impossible to be attained by the use of acids and alkalies except by using large quantities of material,—if, I say, this can be done, and much more, besides the practical utility of analysing complicated minerals and "rocks" in an approximately quantitative manner, on the very spots where they are found, and where it would be impossible to obtain the use of a chemical laboratory,—is it not the duty of our leading chemical and physical philosophers, and, after their *dicta*, of Government itself, to investigate this matter in a proper, thorough, and practical manner, and thus to clear us from the opprobrium which, I fear, we have obtained, in Germany at all events, of "throwing cold water" upon everything new, simply because it is English?

As what I have written on this subject has now been before English chemical readers for many years, in the *Proceedings of the Royal Society*, in your own pages, and those of many of your scientific contemporaries, besides my own books, I will, with your permission, proceed to the description of something which has never been published before—a new blowpipe flux, made by dissolving pure boric acid in a solution of pure phosphoric acid (containing no soda or ammonia) in an evaporating dish on a sand "bath" until crystallisation commences, for, strange as it may seem, crystals are most certainly formed, leaving an intensely acid "mother-liquor," consisting of phosphoric acid and water.

As I have, however, already perhaps made too large a demand upon your space, I will reserve the description of this new reagent and its apparently important results before the blowpipe, for another article.

INFLUENCE OF PEPTONES AND CERTAIN INORGANIC SALTS ON THE DIASTATIC ACTION OF SALIVA.

By R. H. CHITTENDEN and J. S. ELY.

RECENT experiments* on the diastatic action of saliva under various conditions have revealed the fact that human mixed saliva in the presence of an equal volume of artificial gastric juice containing 0·05 per cent of hydrochloric acid, is capable of forming, from a given quantity of starch, a much larger amount of sugar than the same quantity of saliva alone can do under a like degree of dilution; this being the more remarkable when it is remembered that the same percentage of acid by itself greatly retards the diastatic action. This somewhat curious fact has led us to study the individual influence of several bodies of physiological importance on salivary fermentation. It is our conviction that many of the digestive processes of the body are more dependent for their fullest action on the stimulating or other influence caused by the mere presence of many of the digestive products than has hitherto been supposed. Experiment, to be sure, has revealed the fact that several of the products of digestion when present in the digestive mixture in excess, notably sugar in the case of salivary digestion and peptones in gastric digestion, retard the digestive process. Under ordinary circumstances, however, all conditions are favourable, in the normal body, for a rapid absorption of the digestive products, and thus any excessive accumulation is prevented. Schmidt-Mülheim* found in his recent study of proteid digestion, that in the case of dogs, the quantity of peptones present in the stomach was practically the same at all times during the digestion; thus 1, 4, and 6 hours after feeding a dog, 61 grms. of albumin, the stomach contained 3·08 grms., 3·31 grms., and 2·91 grms. of peptones respectively, which would seem to indicate that after the formation of a definite quantity of the digestive products the transportation of these bodies keeps pace with the digestion. Again, there are no facts to warrant the belief that the products of one digestive process necessarily hinder the action of some other allied ferment; indeed, it is ordinarily understood that any accumulation of the digestive products simply hinders the action of that particular ferment by clogging the digestive fluid.

There is nothing inconsistent then in the statement that the products of one digestion may act as a stimulant to some other digestive process. The results of the experiments about to be described show plainly that *peptones, a product of gastric digestion, exercise a decided influence on salivary digestion, stimulating the ferment to increased action, particularly in the presence of acid which by itself completely prevents the conversion of starch into sugar.* If now we are led, in virtue of this fact, to infer that there may be a possible continuation of salivary digestion in the stomach, it follows that the ferment must act at the first period of digestion, when the acid fluids are exceedingly weak. The fact that the quantity of peptones present in the stomach at this stage of digestion may be quite small offers no objection whatever to a possible action of the peptones, since the experiments already quoted, and those about to be described, well illustrate how extremely sensitive the saliva is to a change of conditions, however slight; thus even minute quantities of inorganic salts, even to the extent of only 0·015 per cent, exercise a decided influence on ferment action.

We may also reasonably infer that the saliva is, to a certain extent, a type of the other diastatic fluids of the body, and that the ferment itself is doubtless similar in its action to other like ferments, notably the ferment or ferments of the liver, which presumably convert the glycogen of the hepatic cells into sugar. Thus conditions which modify the diastatic action of saliva may not be wholly without similar influence on other like ferments. It has, therefore, seemed to us that the results of our work may have some bearing upon the recently published experiments of Seegen,† of Vienna, who found that when an aqueous solution of peptones was poured over a small piece of fresh liver, the quantity of sugar formed in a specified time was greater than in a piece of the same liver treated in a like manner but without peptones; at the same time, however, the total amount of carbohydrate matter appeared to be increased in the presence of the peptones. Finding that the peptones themselves had no diastatic action on glycogen, Seegen then concluded that the liver possesses the power of transforming peptones into sugar and carbohydrates which are capable of being converted into sugar.

* Chittenden and Griswold, *American Chemical Journal*, 3, 305.

* *Untersuchungen über die Verdeauung der Eiweisskörper*, Du Bois Reymond's *Archiv f. Physiologie*, 1879, 39.

† *Die Einwirkung der Leber auf Pepton*, Pflüger's *Archiv*, 25, 165.

While our results may in nowise affect Seegen's conclusions, they certainly suggest the possibility that the increase of sugar noticed in the presence of the peptones may be due, in part at least, to some cause other than that attributed by Seegen.

We have attempted at first in our experiments to ascertain whether by themselves or under such conditions as may presumably exist in the body, peptones have any influence on the conversion of amylaceous matter into sugar by the saliva. The amylaceous material employed was starch and glycogen, while the diastatic agent was human mixed saliva, which was usually collected in quantities of 150—250 c.c. by the chewing of some tasteless substance, then filtered and thoroughly mixed before using. The saliva was ordinarily used an hour or two after collecting, and being as a rule always furnished by the same person, possessed approximately the same strength, although control experiments with starch and saliva alone under a like degree of dilution were made in each case. The method employed consisted in dissolving a weighed amount of starch or glycogen in 25 c.c. of water, then adding 50 c.c. of water or other fluid in which a weighed quantity of peptone or other substance was dissolved, and lastly, 25 c.c. of filtered saliva. The mixture, consisting of 100 c.c. of fluid, was then warmed for a definite time, usually 45 minutes, at 40° C., when further action was prevented by boiling the mixture. The fluid was then diluted with water to 500 c.c., and when thoroughly mixed, 50 c.c., or one-tenth of the filtered fluid, was precipitated by cupro-potassium tartrate, according to the method of Maercker, described in another place.* The copper was weighed as metallic copper, from which the percentage of reducing substance calculated as dextrose was determined by the use of Maercker's tables.

Influence of Peptones in Aqueous Solution.

The peptones employed were prepared especially for the purpose and were made as pure as possible. Three samples were prepared from thoroughly washed blood-fibrin by the action of an active gastric juice made from a glycerine extract of pepsin and 0·2 per cent hydrochloric acid, while the fourth was made from coagulated egg-albumin by the use of a similar gastric juice. All four preparations were the products of an active digestion, and were therefore free from syntonin or other preliminary products. The peptones were purified by repeated precipitation and standing under alcohol and ether, while the fourth was especially purified from soluble salts by dialysis. The following results show plainly the action ot the peptones. In each experiment 1 grm. of the dried peptones dissolved in 50 c.c. of water was added to 1 grm. of starch previously boiled with 25 c.c. of water, the 25 c.c. of saliva making a digestive mixture of 100 c.c., in which the peptones were present to the extent of 1 per cent. In the control experiment the mixture was made up to the same volume with water. Different saliva was used in each experiment.

	Without Peptones.		With Peptones.	
Number of experiment.	Wt. Cu in one-tenth.	Total amouut of sugar.	Wt. Cu in one-tenth.	Total amount of sugar.
	Grm.	Grm.	Grm.	Grm.
1.	0·0896	0·4557	0·0962	0·4893
2.	0·0911	0·4633	0·0974	0·4954
3.	0·0915	0·4654	0·1045	0·5315
4.	0·0904	0·4598	0·0977	0·4969
5.	0·0856	0·4354	0·0937	0·4766
6.	0·0835	0·4247	0·0949	0·4826

The increased diastatic action of the saliva in the presence of the peptones is made more plainly apparent by the following table, in which are given the percentage amounts of starch converted into sugar; calling the sugar $C_6H_{12}O_6$, and the starch $C_6H_{10}O_5$.

	Without Peptones.	With Peptones.
1.	41·01 per cent.	44·03 per cent.
2.	41·69 ,,	44·58 ,,
3.	41·88 ,,	47·83 ,,
4.	41·38 ,,	44·72 ,,
5.	39·13 ,,	42·89 ,,
6.	38·22 ,,	43·43 ,,

It is thus seen that the presence of 1 per cent of peptones causes an increased conversion of starch into sugar, amounting on an average to 4 per cent.

Similar experiments made with glycogen yielded like results. 2 grms. of pure, dried glycogen, prepared from *Pecten Irradians** were employed in each experiment, and the digestions continued for 30 minutes. 1 grm. of peptones was used as before.

	Without Peptones.		With Peptones.	
	Wt. Cu in one-tenth.	Total amount of sugar.	Wt. Cu in one-tenth.	Total amount of sugar.
	Grm.	Grm.	Grm.	Grm.
1.	0·1405	0 7297	0·1477	0·7671
2.	0·1286	0·6581	0·1386	0·7144
3.	0·1300	0·6653	0·1328	0·6771
4.	0·1281	0·6556	0·1306	0·6684

A few experiments were then tried, both with glycogen and starch, using 2 grms. of peptones. Following are the results:—

	Without Peptones.	With 1 grm. Peptones.	With 2 grms. Peptones.
	Wt. Cu in one-tenth.	Wt. Cu in one-tenth.	Wt. Cu in one-tenth.
Starch	0·0835 grm.	0·0949 grm.	0·0960 grm.
Glycogen	0·1405 ,,	0·1477 ,,	0·1472 ,,
,,	0·1286 ,,	0·1386 ,,	0·1429 ,,
,,	0·1300 ,,	0·1328 ,,	0·1362 ,,

Here it is to be noticed that the presence of 2 per cent of peptones has but little additional influence on the diastatic action. That peptones themselves were entirely free from carbohydrate matter and that the saliva is wholly without action on the peptones was clearly shown by digesting 2 grms. of peptones with 25 c.c. of saliva. This experiment was repeated twice, but in neither case was any reduction obtained on boiling the diluted fluid with Fehling's solution. Again, the possibility suggested itself that the peptones might exercise some influence on the precipitation of the copper, and that the increase of copper obtained when peptones were present was due not to any stimulating action they might exert on the ferment, but to a precipitation or reduction of the copper. In order to settle this point three digestions were made in the usual manner with 2 grms. of glycogen. No. 1 contained, in addition, 2 grms. of peptones. No. 2 had added to it after the destruction of the ferment by boiling, 2 grms. of peptones, while No. 3 served as a control. A determination of the amount of sugar in the aliquoted fluids gave the following results, clearly showing that the mere presence of the peptones has no influence on the precipitation of the copper:—

No. 1. Wt. Cu in one-tenth.	No. 2. Wt. Cu in one-tenth.	No. 3. Wt. Cu in one-tenth.
0·1472 grm.	0·1403 grm.	0·1405 grm.

There still remained two possible chances of error, viz.' the possibility of the peptones containing a trace of a diastatic ferment, or of their possessing a diastatic action, and secondly, that the slightly acid reaction of the peptone solutions might exert some modifying influence. The former supposition was easily disproved by making a digestion of starch and peptones alone. This led, as would naturally be expected, to a negative result; the solution showing no reducing action whatever. An endeavour was then made to obtain the same result in a somewhat different manner: a series of digestions was made, in which one of the peptone solutions was vigorously

* *American Chemical Journal*, 3, 307.

* Chittenden, *Amer. Jour. Science and Arts*, 10, 26.

boiled before being added to the starch solution, the digestions then being made in the usual manner.

	Without Peptones.	With 1 grm. Peptones.	Peptone sol. boiled.	Peptone sol. boiled and water replaced.
	Wt. Cu in one-tenth.	Wt. Cu in one-tenth.	Wt. Cu in one-tenth.	Wt. Cu in one-tenth.
	Grm.	Grm.	Grm.	Grm.
No. 1.	0·0856	0·0937	0·0950	0·0952
No. 2.	0·0904	0·0977	0·1035	—

That the peptones contain no ferment is plainly apparent, but the slight increase of sugar when the peptone solution is boiled is certainly somewhat singular. Three of the peptones employed in these experiments gave, when dissolved in water, very faintly acid solutions. The acidity of 1 grm. of peptones, however, was never sufficient to neutralise the alkali of 25 c.c. of saliva.* The fourth sample, which was purified by dialysis, gave a neutral solution, and this sample did not differ in its action in the least from the other three. An attempt was made, however, to neutralise one of the peptone solutions, previous to the digestion, by the use of an exceedingly dilute alkali. The following results were obtained:—

Without Peptones.	With 1 grm. Peptones.	With 1 grm. neutralised Peptones.
Wt. Cu in one-tenth.	Wt. Cu in one-tenth.	Wt. Cu in one-tenth.
0·0915 grm.	0·1045 grm.	0·0991 grm.

The slight decrease of copper in the neutralised peptone, as later experiments would seem to indicate, is due probably to the retarding influence of the alkali salt formed by neutralisation, although it seems hardly possible that such a minute trace could exert any influence whatever on the action of the saliva.

O. Nasse† in his work on unformed ferments, found that in 4 per cent. solutions of certain inorganic salts there was an increased ferment action. It therefore seemed desirable to ascertain in the present case whether the inorganic salts contained in the peptones could exert any influence on the salivary ferment. The four samples of peptones contained the following percentages of ash:—

No. 1.	No. 2.	No. 3.	No. 4.
1·71 per cent.	0·89 per cent.	1·25 per cent.	1·58 per cent.

With the exception of No. 4, the ash was composed of sodium chloride, sodium phosphate, and calcium phosphate.

No. 4, which was prepared from coagulated albumin and purified by dialysis, left an ash composed wholly of calcium phosphate. The following results show the individual influence of the three inorganic salts on the diastatic action of saliva when present in the digestive fluid in approximately such percentages as the peptones give when added to the starch and saliva mixture:—

FIRST EXPERIMENT.

	Wt. Cu in one-tenth. Grm.
Saliva and starch alone, ...	0·0872
,, ,, +0·012 grm. NaCl = 0·012 per cent	0·0862
,, ,, +0·024 ,, ,, = 0·024 ,,	0·0925
,, ,, +0·012 ,, Na_2HPO_4 = 0·012 per ct.	0·0886
,, ,, +0·024 ,, ,, = 0·024 ,,	0·0834

SECOND EXPERIMENT.

	Wt. Cu in one-tenth. Grm.
Saliva and starch alone, ...	0·0844
,, ,, +0·015 grm. $CaHPO_4$ = 0·015 per ct.	0·0839
,, ,, +0·030 ,, ,, = 0·030 ,,	0·0870

From these results it is apparent that no one of the inorganic salts in the peptones is present in sufficient quantity to have any stimulating action whatever in aqueous solution, for increased diastatic action is noticed only in the presence of 24 milligrams of sodium chloride, an amount much larger than the total ash of 1 grm. of peptones. Again, peptone No. 4, which was freed from all trace of chloride by dialysis, had exactly the same stimulating effect as the other samples.

In order to ascertain exactly what the influence of the *mixture* of inorganic salts, as present in the peptones, would be, a series of digestions was made, in two of which the ash of 1 grm. and of 2 grms. of peptones respectively were employed; the ash, as in the experiments with the peptones themselves, being dissolved in 50 c.c. of water, and in this manner added to the starch solution previous to the addition of the 25 c.c. of saliva. The peptones employed were the ones which contained 1·71 per cent of ash; thus the digestive mixtures contained respectively 0·017 and 0·034 per cent of inorganic matter. The following results were obtained:—

Saliva and Starch alone.	With Ash from 1 grm. Peptones.	With Ash from 2 grms. Peptones.
Wt. Cu in one-tenth.	Wt. Cu. in one-tenth.	Wt. Cu. in one-tenth.
0·0862 grm.	0·0851 grm.	0·0715 grm.

It is thus very apparent that the stimulating action of the peptones is not due to the inorganic salts contained in them, for these latter, as the foregoing experiment shows, have, by themselves, in aqueous solution, a retarding influence. We therefore deem it proven that peptones under such conditions as have already been described, have in aqueous solution a stimulating influence on salivary digestion. In other words, peptones when present to the extent of 1·2 per cent cause, under the same conditions as saliva alone, an increased conversion of starch into sugar, amounting on an average to 4 per cent.

(To be continued.)

* Neutral saliva appears to have as great a diastatic action as saliva of normal alkalinity. Thus while a digestion made with freshly collected alkaline saliva gave 0·0905 grm. Cu, a portion of the same saliva neutralised gave 0·0943 grm. Cu under the same conditions.

† *Untersuchungen über die ungeformten Fermenten*, Pflüger's *Archiv*, 11, 138.

NOTICES OF BOOKS.

Journal and Proceedings of the Royal Society of New South Wales, 1881. Vol. XV. Edited by A. LIVERSIDGE, Professor of Chemistry and Mineralogy in the University of Sydney. Sydney: Richards. London: Trübner and Co.

THIS volume does not contain many papers specially interesting to the chemist. There is a memoir by W. A. Dixon, F.C.S., on the "Inorganic Constituents of some Epiphytic Ferns," of some importance as proving that the amount of ash in the growing fronds is quite as high as in the leaves of plants which obtain their nourishment directly from the soil. The inorganic principles most abundant in ordinary vegetation play here likewise the leading part. Thus in the ash of *Platycerium grande* potash, lime, and phosphoric acid are respectively present to the extent of, in round numbers, 33, 21, and 9 per cent. A remarkable phenomenon is the presence of 11 per cent soda (exclusive of sodium chloride) and of 8 per cent of alumina. On turning to the analysis of the wood and bark of the tree upon which this fern was a parasite, we find no alumina and no soda except traces of sodium chloride. It appears, therefore, that the Platycerium must obtain these constituents from the dust which collects behind the crown of the plant. It may be mentioned that Mr. Dixon took the precaution of obtaining his specimens from localities far from towns and cultivated grounds. The ash of *P. Alcicorne* taken from different localities showed considerable variation, though alumina was always largely present. Here lime and magnesia seem capable of to some extent replacing each other. Thus in one specimen were found potash 20, soda 17, sodium chloride 12, lime 13, and magnesia 14 per cent.

In another the potash is 40 and soda 21, whilst the lime is only 5 and the magnesia 4 per cent. *Asplenium nidus* is free from alumina, and contains no soda except in the form of sodium chloride.

Investigations of this kind are exceedingly valuable, and should be extended.

OBITUARY.

THE LATE PROFESSOR WŒHLER.

One of the links between the chemistry of the present day and that of the earlier part of the century has just been severed. Friedrich Wœhler, for many years Professor of chemistry at the University of Göttingen has finished his long and honourable career. He was born in the year 1800, being the junior of Prof. Dumas by a few days only. He was the favourite pupil of the great Berzelius, and displayed in an eminent degree the patience, the exactitude, and the sobriety of judgment which characterised his illustrious master. From about 1821 to within the last few years he produced what may be called a stream of valuable researches, which are embodied in no fewer than 225 memoirs presented to learned societies or published in the scientific journals.

Amongst his labours, judging from a purely scientific point of view, the foremost place belongs to the "epoch-making" discovery of the synthesis of urea. This was the first instance of an organic compound being produced artificially without the intervention of life. The discovery produced a great sensation, as breaking down the supposed absolute distinction between the organic and the inorganic worlds.

More recently he distinguished himself by the isolation of metallic aluminium, and by his labours on the platinum metals and on their practical metallurgy. In these researches he was associated with his friend the late H. Sainte-Claire Deville.

In conjunction with another of his friends, Justus Liebig, he produced also certain important researches in organic chemistry. Their joint investigation on the derivatives of uric acid has proved, in the hands of their successors, a perfect mine of interesting novelties, and their memoir on the nature of the benzoic compounds brought into harmonious connection a hitherto desultory mob of phenomena.

Since the death of Liebig, Wœhler has been the first editor of that universally esteemed journal *Liebig's Annalen*, though of late years the principal part of the editorial duties have devolved upon his colleagues, Professors Kopp, Hofmann, Kekulé, Erlenmeyer, and Volhard.

As a colleague, a teacher, and in every relation of private life, Wœhler was esteemed and beloved for the kindliness and geniality of his disposition, his modesty, and uprightness. Many successive generations of students, now dispersed over the world, can bear witness to his readiness to perceive and aid merit. He gave his pupils his own ideas, aided them in carrying out the needful investigations, and kept his share in the work a secret. Those who maintain that a life devoted to science renders a man harsh, proud, and selfish, will find in the person of Friedrich Wœhler a brilliant refutation of their doctrine.

Cause of Acid Reaction in Certain Kinds of Paper.—Prof. Feichtinger.—Papers sized with rosin-size were found to have a more or less acid reaction due to free sulphuric acid, which has never been observed in samples sized with animal glue. The acid is probably derived from the alum or aluminium sulphate used in sizing, which is decomposed by contact with the vegetable fibre, as takes place in dyeing, a basic salt being deposited upon the fibre, and a portion of acid liberated.—*Chemiker Zeitung.*

CORRESPONDENCE.

SECONDARY BATTERY.

To the Editor of the Chemical News.

Sir,—As the question of secondary batteries is at present engaging the attention of electricians and chemists, I would like to bring before your readers a form which I have tried a few experiments with, and which seems very promising. It occurred to me some time ago that Bennett's* cell might be improved if there were oxide of iron present to be reduced by the hydrogen evolved, and upon trial I found that a plate of zinc and a plate of rusty iron, immersed in caustic soda solution, gave a very constant current for some time. Now, suppose such a battery used for a considerable time: the zinc would become coated with zinc oxide, and the iron oxide reduced to spongy iron. Suppose that now a current is sent into the cell in a direction opposite to that of its own current, the ZnO will be reduced to metal, and the iron oxidised; consequently the cell will be refreshed, and able to give out a strong current again until all the iron oxide is reduced.

As caustic soda would not keep very long without becoming carbonate, I tried sodium carbonate in the cell with which I experimented, and which consists of a rusty iron cylinder containing the solution, and a cylinder of zinc which had been superficially oxidised by long exposure to the air. This combination only gives a trace of current of itself, but when charged with at least three Daniell cells is capable of giving out a very considerable secondary current. I have no doubt that other neutral salts, of better conducting power, would be more suitable than sodium carbonate, and I intend to continue my experiments in that direction, but in the meantime would be glad of information as to whether such a combination has been suggested before as a secondary battery, for, if so, I am ignorant of it.—I am, &c.,

Thomas Farrington.

4, Waterloo Place, Cork, October 10, 1882.

A WARNING.

To the Editor of the Chemical News.

Sir,—Would you kindly permit me, through the medium of the Chemical News, to forewarn chemists against a foreigner (Swiss, I believe) giving the name of Schmidt, Ph.D., who represents himself as an analyst in search of employment. He represented to me that he was engaged at a neighbouring chemical works, to commence duties the following Monday, and being in need of ready cash I advanced him £1. On his never turning up, as arranged, to refund me, I made enquiries, and find that his stories are entirely false, and he, of course, "non est," and doubtless on his rounds trying to impose on someone else.—I am, &c.,

Alexander Proudlock.

Chemical Laboratory, Aireside Iron Works, Leeds, October 11, 1882.

FORMATION OF OZONE.

To the Editor of the Chemical News.

Sir,—If Mr. R. Lamont will consult my paper "On the Atmospheric Oxidation of Phosphorus" (*Journ. Chem. Soc. Trans.*, 1880, p. 797), he will find that oxygenated water is not materially, if at all, decomposed by dilute ozone, and also that oxygenated water is one of the principal products of the oxidation of phosphorus in the presence of water. It is necessary, therefore, and for the other reasons given in my recent article (Chemical News,

* Zinc and iron in caustic soda solution.

vol. xlvi., p. 141), that if Mr. Lamont would correctly represent by equations the chemical changes that occur during the process to which I have made reference, he must introduce water.—I am, &c.,

C. T. Kingzett.

Chemical Laboratory, 17, Lansdowne Road,
Tottenham, N., October 16, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 13, September 25, 1882.

Analysis of the Milk of the Galibis Women at the Jardin d'Acclimation.—Mme. Madeleine Brès.—These milks are rich in lactose and butter, whilst the proportion of caseine is exceedingly small.

No. 14, October 2, 1882.

The Coercitive Force of Steel rendered Permanent by Compression.—L. Clémandot.—Steel tempered by compression, that is, cooled under pressure, retains its coercitive power in spite of re-heating, forging, &c.

Nature of the Vibratory Movements which accompany the Propagation of Flame in Combustible Gaseous Mixtures.—MM. Mallard and Le Chatelier.—When a combustible gaseous mixture included in a tube closed at one end and open at the other, is kindled at the free extremity, the flame is propagated at first slowly, very regularly, and without producing any sound; then it begins to oscillate, its speed is accelerated, and at last there is heard a sound more or less intense. The authors have measured the duration of the vibratory movements, their amplitudes, their influence on the lustre of the flame, and their mean speed of propagation.

Action of Anhydrous Aluminium Chloride upon Acetone.—E. Louïse.—Acetone, mixed with anhydrous aluminium chloride, enters into ebullition, and on applying a gentle heat and keeping up the reaction by successive additions of aluminium chloride, the mixture of the two substances is transformed into a blackish solid mass, over which is a stratum of a black liquid. If the crude product is distilled in a current of steam, there passes over a yellow liquid, insoluble in water. The most volatile portion of the purified mixture is chiefly composed of mesityle oxide, $C_6H_{16}O$. The less volatile portion consists of crystalline phorone and of higher products of condensation which do not crystallise.

Chemiker Zeitung.
Vol. vi., No. 48.

Chemical Laboratory of the Royal Mining Academy of Clausthal.—Prof. W. Hampe.—A lengthy paper with several illustrations.

No. 49, 1882.

Preparation of Pure Hydrochloric Acid.—Dr. Giudice.—The author adds to the sulphuric acid employed a small quantity of an oxidising agent, such as potassium bichromate or permanganate, and causes the gas, before it is conducted into water, to pass over mercury in a Liebig's bulb-tube. The oxidising body prevents the formation of sulphurous anhydride in presence of organic matter, and liberates bromine and iodine if present. Arsen-chloride is decomposed in contact with the mercury and free chlorine, bromine, and iodine, are absorbed.

Detection of Arsenic Microscopically.—Dr. H. Hager.—The process depends on the reducing-action of oxalic acid or ammonium oxalate upon arsenic and arsenious acids in heat. If the liquid to be tested contains no fixed heavy metals, which when partially or entirely reduced present dark masses, the detection can be effected microscopically. In concentrated sulphuric acid it is sufficient to heat 2 or 3 c.c. of the colourless sample with some colourless crystals of oxalic acid in a test-tube. If the acid contains more than a trace of arsenic, it is coloured brown, but it remains colourless if pure. If other liquids are to be examined, *e.g.*, phosphoric or acetic acids, 1·5 c.c. of the acid is taken mixed with 3 drops of glycerin, 0 25 grm. oxalic acid, and a few drops of ammonia. The mixture is heated, and a drop is placed on a glass slip. The finely-divided arsenic can be seen with the microscope as a dark grey or a black mass.

Detection of Lead in Presence of Ammonium Citrate.—S. Rovera.—Whilst examining quinine citrate for an admixture of quinine sulphate, the author observed that lead in presence of ammonium citrate is not precipitated from an alkaline solution by sulphuric acid or an alkaline sulphate. It is, however, completely precipitated by potassium or sodium carbonate.

Cosmos Les Mondes.
Nos. 1 and 2, September 2 and 9, 1882.

These numbers contain no chemical matter.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 7.

The Daily Course of Rainfall.—F. Augustin.—The author, from twenty years' observation of the hourly rainfall made at Prague and compared with pluviometric determinations at Modena, Bern, Vienna, and Zechen, concludes that both in the quantity of downfall and in the frequency of rainfall there are three daily maxima and three minima. The first minimum is as regards frequency from midnight to 1 a.m., but as regards quantity from 2 to 3 a.m. This in all the stations except Bern is the most decided minimum, both for quantity and frequency. The first maximum coincides with or follows shortly after the minimum daily temperature. As regards frequency, it occurs from 6 to 7 a.m., but as regards quantity, from 7 to 8. The second minimum, both in quantity and frequency, is about noon. The second maximum is a short time after the maximum daily temperature, from about 4 to 5 p.m. The third minimum is about 7 p.m., and the third maximum is, in frequency, from 8 to 9, and in quantity from 9 to 10 p.m.

Influence of Artificial Manures upon the Physical Conditions of the Soil.—Prof. E. Wollny.—The author remarks that a fruitful arable soil has its smallest particles not densely aggregated, but in a crumbly, fragmentary state, so that air and water can circulate between them. Copious manuring with substances rich in chlorides, nitrates, and sulphates, and saline irrigations, have an injurious effect upon the texture of clay soils. Quicklime has the most favourable action.

Changes in the Properties of the Nitre Ferment by Cultivation.—R. Warington.—From the "Report of the British Association for 1881."

Experiments on a Four Years' Rotation.—Dr. A. Voelcker.—From the *Journal of the Agricultural Society.*

Experiments on the Uninterrupted Cultivation of Wheat and Barley at Woburn.—Dr. A. Voelcker.—From the *Journal of the Agricultural Society.*

Cultural Experiments on the Field at Grignon in 1881.—Prof. P. P. Dehérain.—The manures applied to the different plots seem to have been altered irregularly, so that it is difficult to find comparable conditions, or to know to what influence any given result is to be ascribed.

Manuring with Phosphoric Acid in the Department Nord (France).—M. Ladureau.—Already noticed.

Agricultural Value of so-called dissolved Wool.—Prof. A. Petermann.—Wool dissolved by means of sulphuric acid, or of high-pressure steam, and containing its nitrogen to a large extent in the form of tyrosine and leucine, has, at least in the sandy loam experimented on, a very favourable effect.

Action of Dissolved and of Finely-ground Phosphates in the Cultivation of Swedes.—Dr. A. Voelcker.—From the *Journ. Agricul. Soc.*

Agricultural Value of the Different Combinations of Phosphoric Acid.—Dr. E. Wildt.—The experiments show no marked difference between the action of reverted and precipitated calcium phosphate, whilst phosphoric acid soluble in water produced in almost all cases a more considerable increase of the yield than that soluble in citric acid, the reverted, and the precipitated forms.

Composition of Various Materials Suitable for Composts.—Prof. Petermann.—Tables showing the nitrogen, phosphoric acid, potash, and lime present in various kinds of industrial refuse and in pond-muds.

Researches on the Digestibility and the Quantitative Determination of the Albumenoids.—Dr. A. Stutzer.—The determination of the proteine nitrogen and the separation of the proteine compounds from other nitrogenous bodies can be easily and accurately effected. The so-called proteine matters of cattle foods consist of two physiologically and chemically distinct classes, which may be known as albumenoids and as nucleine. The albumenoids are converted into soluble compounds, both by the acid gastric juice and by the alkaline pancreatic secretion. Not so nucleine,—a fact which must be considered in determining the value of articles of food. The digestibility of the proteine substance depends in the first place on their chemical composition, *i.e.*, on their proportion of digestible albumen. The albumenoid nitrogen can be best determined and separated from nucleine nitrogen by means of artificial digestion.

Effects of External Influences on the Formal Development of the Wheat Plant.—Dr. H. v. Bretfeld. This paper is more of a botanical than of a chemical character.

Examination of a Mixture of the Seeds of Weeds used in Cattle Food.—Prof. F. Nobbe.—The author considers this mixture not injurious, but low in nutritive value.

Experiments on the Growth of Various Plants.—Dr. Kraus, Prof. Leydhecker, and J. Tudor.—Not adapted for abstraction.

Influence of Lopping the Crown and the Roots of Fruit Trees on Transplantation.—Prof. Magerstein and F. Bilek.—This paper does not fall within the scope of the CHEMICAL NEWS.

Experiments on Vegetation in Atmospheres Rich in Carbonic Acid.—P. Dehérain and L. Maquenne.—Plants which have an excess of carbonic acid at command are found to derive a decided advantage.

Communication on Sorghum tartaricum.—Dr. de Leeuw.—The seed of this plant, known in commerce as dari, contains 66·6 per cent of starch, and is used in Belgian distilleries.

Products of the Distillation of Beet-dregs.—Ch. Lauth.—The concentrated liquid when submitted to dry distillation yields ammonia, methylic alcohol, acetic acid, small quantities of the higher fatty acids, nitriles of these acids, methylamine, and tar.

Influence of Different Steeping Waters.—Karl Michel.—Experiments on the action of distilled water and spring water in steeping barley.

Detection of Myronic Acid in Oil-cake (a preliminary communication).—V. Dirks.—The oil-cake is mixed with water, allowed to stand, and the oil of mustard is distilled into an alkaline solution of permanganate.

Justus Liebig's Annalen der Chemie,
Band 214, Hefts 1 and 2.

Hydro-cinchonidine.—O. Hesse.—Hydro-cinchonidine melts at 229° to 230°. It crystallises from hot dilute alcohol in splendid hexagonal leaflets, but from strong alcohol in short prisms. In alcohol it dissolves less readily than cinchonidine and homo-cinchonidine. In chloroform, even boiling, in ether, and water, it is very sparingly soluble. It dissolves readily and without colouration in strong sulphuric and nitric acids. Its acid solutions, even when much diluted, do not display the slightest blue fluorescence. With chlorine and excess of ammonia it gives no colouration. In caustic alkaline solutions and in lime and baryta water it is insoluble. In an acid solution it is only very slowly attacked by potassium permanganate. Its composition is $C_{19}H_{24}N_2O$.

Urea and Thio-urea Derivatives of Phthalic Acid.—Dr. A. Piutti.—The author has obtained and described phthaluric acid and its salts; phthalureide, thio-phthaluric acid, and certain of its salts.

Communications from the Chemical Laboratory of the Royal School of Forestry at Aschaffenburg.—These consist of the following syntheses by means of malonic ester: Methenyl-tricarbonic ester and acetmalonic ester, by M. Conrad and M. Guthzeit; ethenyl-tricarbonic ester, by C. A. Bischoff; mono-chlor-ethenyl-tricarbonic ester, by C. A. Bischoff; propenyl-tricarbonic ester, by C. A. Bischoff; propyl- and isopropyl-ethenyl-tricarbonic ester, by G. Waltz; isallylen-tetra-carbonic ester, by C. A. Bischoff; acetylen-tetra-carbonic tetraethyl-ester, by M. Conrad and C. A. Bischoff; acetylen-tetra-carbonic diethyl-ester, by M. Guthzeit; dicarbon-tetra-carbonic ester, by M. Conrad and M. Guthzeit.

Action of Phosphorus Penta-chloride upon Acid Amides (Second Memoir).—O. Wallach.—Not adapted for useful abstraction.

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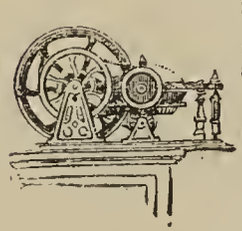

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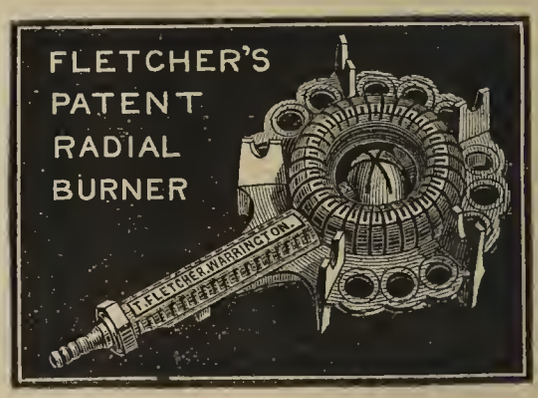

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THE CHEMICAL NEWS.

VOL. XLVI. No. 1196.

ANALYSES OF INDIAN WOOD.

By W. R. CRIPER, F.I.C., &c.

THE trees chiefly used for fuel in the North West Provinces of India are Mango (*Mangifera Indica*), Sakhu or Sál (*Shorea robusta*), and Dhák or Dháka (*Butea frondosa*). Samples for analysis were taken in the month of June from a stock ready for use, which had been lying exposed to the atmosphere during the preceding hot season, and was consequently dry, *i.e.*, containing about 10 per cent of moisture only. The samples included the bark.

	Mango.	Sál.	Dháka.
Carbon	42·72	43·58	40·61
Hydrogen	5·70	5·45	5·11
Oxygen and nitrogen	36·23	38·09	35·36
Ash	2·88	1·24	6·25
Sand	2·97	0·44	1·00
Water..	9·50	11·20	11·67
	100·00	100·00	100·00
Heat units, calculated from an analysis, not including sand . ..	3634	3458	3259

During the rainy season about 20 per cent of water is the usual amount contained in the wood, for which percentage the heat units given by Sakhu or Sál would be 3054, which may be considered the average.

In a series of 31 samples of coal from the Ranigunge district, Bengal, analysed by the Indian Geological Survey (vide *Records of the Geological Survey of India*, vol. x., p. 155), the heating effect of the best sample is given as 7040 heat units.

The ratio of coal to wood in India may therefore be considered as 2·32 to 1, *i.e.*, for equal weights the coal has 2·32 times the heating power of ordinary wood, theoretically.

LABORATORY NOTES.

By R. ROMANIS.
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THE town of Rangoon is supplied with water from the Royal Lake, a reservoir made by some of the former kings of Pegu, near the Great Pagoda. It is filled during the rains which last from June to October. During the hot weather it slowly shrinks, while a mass of vegetation is developed in the water. Samples of the water have been regularly examined by the ammonia process, once a month since May, 1881. The results are appended. The effect of the rains in diluting the organic matter is apparent in July, and is at its maximum in August, the wettest month of the year. A curious evolution of free ammonia is shown in March, possibly connected with some stage in the development of the organisms in the water. Although the water contains so much organic ammonia as would probably ensure its being condemned at home, yet it has made a great improvement in the health of the quarter of the town to which it was first laid on about five years ago—a marshy district near the river where fever greatly prevailed, possibly because the wells formerly in use were so bad that any change was for the better.

	Free Ammonia.	Alb. Ammonia.
1881—May	0·00	0·60
June	0·02	0·68
July	0·00	0 36
August ..	0·02	0·24
September .	0·05	0·26
October 10	0·00	0·30
October 20	0·00	0·32
November .	0·04	0·36
December .	0·00	0·36
1882—January ..	0·00	0·38
February ..	0·00	0·68
March 11 ..	0·16	0·42
March 15 ..	0·16	0·44
April.. ..	0·00	0·64
May	0·00	0 64
June	0·00	0·72
July	0·01	0·82
August ..	0·00	0·32
September .	0·06	0·26

JAPANESE SOILS—A NATURAL CEMENT.*

By Dr. O. KORSCHELT.

THE author of this paper, the chemist to the Geological Survey Department of the Japanese Government, was led to look for a natural cement. Such cements are formed by mixing burnt lime with substances of volcanic origin, generally tufas. Since a preliminary burning is not necessary, neither in many cases any grinding, the cement can be formed on the spot where it is required for building without the intervention of any special factory, such as is required for Portland or Roman cement. Materials for the manufacture of such cements have been found in a few places in Europe; in Italy between Rome and Viterbo, and near Naples at Pozzuoli (whence *Pozzuolana*); in Germany, at Brohlthal and Nettethal near the Laacher See, near Andernach and Neuwied on the Rhine, and in the Riesgau, also in the north of Ireland and in Auvergne. Those from Germany and the last-named places are known, when in the powdered condition, as *trass*: they all contain constituents which are soluble in hydrochloric acid to the extent of about one-half their weight. Besides these, the island of Santorin, and one or two other Grecian islands, furnish a siliceous earth, used for the same purpose, which is insoluble in hydrochloric acid, but contains much silica soluble in potash solution.

Dr. Korschelt first experimented with the tufa rocks of Japan, which differ from those used in Europe for making cements in being chiefly augite-andesite and trachyte, whilst the European rocks are, for the most part, leucite-bearing tufas: experiments with these rocks were unsuccessful. It was noticed, however, that some of the soils of Japan yielded a large amount of matter to cold concentrated hydrochloric acid, and contained large quantities of hydrated oxides of iron and aluminium. Layers of soil, 25 centimetres in thickness, to a depth of 1·5 metres, taken from the city of Tokio (Yedo) were analysed. The dry soil from one of the low lands gave up from 75 to 80 per cent to hot hydrochloric acid; of this about 30 per cent was silica and 30 per cent alumina and ferric oxide. From 1·5 to 3 per cent of potash soluble in hydrochloric acid was found in the lower layers of this soil, but this is an unusual amount. These soils are generally called loams, but chemically they can scarcely come into that class, as they contain little or no quartz sand, and only about 10 per cent of mineral sand, but 50 to 60 per cent of easily decomposable silicates of the nature of zeolites, and about 30 per cent of aluminium and iron hydrates. The insoluble mineral sand consists principally of sanidine

* Abstract of Paper in *Mittheilungen der Deutschen Gesellschaft für Natur und Volkerkunde Ostasiens*, 1881.

and plagioclastic felspar with a little augite, the tufa from which it is formed being trachytic or augite-andesite.

These tufa soils have a very low specific gravity, less than that of all other soils, excepting only peaty soils. In fifteen samples the specific gravity varied from 2·097 to 2·291, the mean being 2 156, whilst the *apparent* specific weight, obtained by dividing the absolute weight of a given volume of the soil in its natural condition by the weight of an equal volume of water, was between 1·038 and 1·270, the mean being 1·135.

Mechanical analyses were made of twenty-two samples by means of Schöne's and Ort's apparatus. Only about 3 per cent of the soil particles had a greater diameter than 0·5 millimetres, and about 70 per cent were less than 0·09 millimetre in diameter. It was also found that the physical composition of the soils varied comparatively slightly either with varying depth or from different localities. The chemical composition of these tufa soils also varies but little: we give the analyses of one series from a village in Saitama Ken as an example:—

	Depth of Soil in centimetres.				
	0—25.	25—37.	37—50.	50—75.	75-100.
Hygroscopic water..	12·49	13·01	14·90	18·34	19·10
Loss on ignition ..	29 99	32·66	30 68	32·28	33·10
Alumina	8·30	9·81	11·07	11·33	11·40
Ferric oxide	5·95	6·20	6·79	9·24	8·66
Lime..	0·69	0·60	0 32	0·21	0·15
Magnesia..	0·34	0·34	0·44	0 32	0·37
Potash	0·05	0·07	0·06	0 05	0·06
Sulphur trioxide ..	0·07	0·09	0·07	0 07	0·12
Phosphorus pentoxide	0·07	0·07	0·05	0·07	0·07
Carbon dioxide ..	0·08	0·07	—	—	—
Carbon	7·22	6 30	2·86	1·56	1·63
Nitrogen	0·39	0·35	0·18	0·12	0·12

Some of these tufa soils, which were of a whitish colour, refused to form a satisfactory cement when mixed with lime, but those of a reddish yellow or reddish brown colour, when mixed with lime paste, quickly set and hardened, forming a highly satisfactory cement. The chemical action taking place at the time of mixing was indicated by a rise in temperature of 7° C. Suitable soils were found on nearly all the high parts of Tokio, and to a depth of about 20 feet. Complete analyses of some typical specimens are given, and the composition of a suitable tufa earth is stated to be as follows:—Organic matter, 1 per cent; zeolites and hydrates of sesquioxides, 85; clay, 1·5; quartz sand, 1·5; and mineral sand, 11 per cent. The most suitable mixture was found to be 1 volume of burnt lime, made to a stiff paste, mixed with 6 volumes of earth. The hardness of the cement was found to be sufficient for most purposes, and also its resistance to crushing, although this latter could not be determined with exactness owing to the want of a testing apparatus; however, it always resisted a pressure of over 12 kilogrms. per square centimetre on a thickness of 3 centimetres. It is also impermeable to water. Experiments were also made by mixing the earth with sand before adding the lime; this increased the density and value of the cement, but is not to be generally recommended owing to the difficulty of obtaining sand sufficiently sharp for the purpose; in many places, however, a pumice-tufa is met with which answers admirably for mixing with the earth.

The tufa earth is met with over a large part of Japan, and in many different districts. Its value for the building of dwelling-houses can scarcely be overrated. From its abundance houses can be constructed of it as cheaply as, if not more cheaply than, of wood, and by its means the fearfully destructive fires, which are estimated to burn down the whole of any large town within ten years, would be to a large extent prevented.* The habits of the people would not allow of brick or cement houses being generally adopted at once, but there could be no objection to the two side-walls of the house being of this cement.

* In the winter of 1880-81, in the city of Tokio alone, considerably more than 20,000 houses were destroyed by fire.

In a postscript the author states that he finds that a decomposed granite grit found in parts of Japan where the tufa is absent forms an excellent cement material, and is indeed a most acceptable supplement to the tufa earths.

Dr. Korschelt makes some suggestions as to a new system of soil nomenclature by which the confusion now arising from using certain terms, such as sand and clay, sometimes in a chemical sense and sometimes in a physical sense, would be avoided. The six chemical constituents, clay, sand (quartz), mineral grains (other than quartz), zeolites, including hydrates of sesquioxides, carbonate of lime, and humus, are taken as the basis of chemical distinctions; and the fine earth is divided according to the diameter of the particles, ascertained by the mechanical analysis, into four principal divisions; by making compound words, often of some length, denoting the chemical and physical constituents, the constitution of any soil can be expressed with accuracy.

The results of previous investigations of Japanese soils, and remarks on their agricultural value are given. E. Kinch (*Transactions of the Asiatic Society of Japan*, 1880) analysed several soils: among these were four tufa soils differing but little in composition from those examined by the author. These soils all contained magnetic oxide of iron, as indeed do the great majority of Japanese soils, and in the surface-soil the amount is much larger than in the subsoil, indicating a considerable denudation, whereby the heavy magnetic oxide was left and accumulated in the top soil. The views of D. Brauns on the geology of the neighbourhood of Tokio ("Memoirs of the University of Tokio," No. 4) are criticised and dissented from.

In considering the agricultural attributes of these tufa soils, the author endorses the view expressed by Kinch (*loc. cit.*), that these soils are admirably adapted from their physical properties to the system of agriculture pursued by the Japanese farmer, but that viewed as a storehouse of plant-food they are usually poor. They contain a very large amount of the finest particles, but are quickly and easily cultivated and sufficiently adherent. They possess great absorbent and retentive powers for water, and their dark colour is favourable to the absorption of heat. Moreover, the large amount of zeolitic matter they contain gives them powerful absorptive powers for many kinds of plant food, and renders them very thankful for rich manuring.

In general manuring, cropping, and cultivation the Japanese farmer has but little to learn from the European, but rather the converse; he fails, however, in knowledge of special manures, and the smallness of his holdings prevents many improvements in implements, and in other ways.

The analyses of soils given by Dr. Korschelt show a gradual decrease of combined nitrogen from the surface soil downwards in a very interesting manner. In one series taken at different depths the nitrogen in the top layer of 25 centimetres is very large in amount, being 0·521 per cent, and decreasing steadily, till at 1 metre depth it is but 0·131 per cent. In another series the surface soil contains 0·372 per cent, which decreases to 0·095 at one and a half metres depth. In another the decrease is from 0·208 to 0·08 per cent; and again, in a fourth series, from 0·396 at the surface to 0·124 per cent of nitrogen at the depth of one metre. When we remember that 0·1 per cent in such a soil means 3000 lbs. of combined nitrogen in one acre to the depth of one foot, the immense stores of nitrogen in the soils are realised.

The percentage of carbon in the soils from Saitama is also very high, and the ratio between the amount of carbon and that of the nitrogen is higher than has been found in most soils.

What is most needed in Chemical Laboratories?—J. Bing.—The author's answer to this question may be summarised in two words—efficient ventilation.—*Journal für Praktische Chemie.*

INFLUENCE OF PEPTONES AND CERTAIN INORGANIC SALTS ON THE DIASTATIC ACTION OF SALIVA.

By R. H. CHITTENDEN and J. S. ELY.

(Concluded from p. 182).

Influence of Peptones in Acid Solution.

PREVIOUS experiments* have plainly demonstrated the extreme sensitiveness of the saliva to the action of dilute acids. Thus the addition of 50 c.c. of 0·05 per cent hydrochloric acid to a digestive mixture, thereby making the fluid contain but 0·025 per cent of acid, very greatly diminishes the diastatic action. This result has been recently verified by J. N. Langley,† as also the results of Chittenden and Griswold in regard to the destruction of the salivary ferment by gastric juice and by 0·2 per cent hydrochloric acid at 40° C.

An attempt was now made to ascertain the influence of peptones in an acid solution of the above strength, viz., 0·025 per cent. The experiments were conducted in the same manner as the preceding, with this exception: the peptones, instead of being dissolved in water, were in each case dissolved in 50 c.c. of 0·05 per cent hydrochloric acid. 1 grm. of peptones was used in each experiment, starch being the amylaceous material employed.

	Saliva alone.		Saliva and Acid.		Saliva, Acid, and Peptones.	
	Wt. Cu in one-tenth.	Total amount of sugar.	Wt. Cu in one-tenth.	Total amount of sugar.	Wt. Cu in one-tenth.	Total amount of sugar.
	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.
1.	0·0896	0·4557	0·0076	0·0389	0·1068	0·5428
2.	0·0911	0·4633	0·0079	0·0405	0·1070	0·5439
3.	0·0915	0·4654	0·0098	0·0502	0·1060	0·5388
4.	0·0835	0·4247	—	—	0·0985	0·5010

The percentage amounts of starch converted into sugar under the three conditions are as follows:—

	Saliva alone.	Saliva and Acid.	Saliva, Acid, and Peptones.
1.	41·01 per cent.	3·50 per cent.	48·85 per cent.
2.	41·69 ,,	3·64 ,,	48·95 ,,
3.	41·88 ,,	4·51 ,,	48·48 ,,
4.	38·22 ,,	—	45·09 ,,

Similar experiments were tried with glycogen, 2 grms of this substance being dissolved in 25 c.c. of water and employed in the same manner as the starch; 1 grm. of peptones was used as before. The following results were obtained:—

	Saliva alone. Wt. Cu in one-tenth.	Saliva and Acid. Wt. Cu in one-tenth.	Saliva, Acid, and Peptones. Wt. Cu in one-tenth.
1.	0·1300 grm.	0·0049 grm.	0·1408 grm.
2.	0·1281 ,,	trace	0·1424 ,,

It is thus seen that the presence of 1 grm. of peptones exercises a very remarkable influence on the diastatic action of saliva in an acid solution of the above strength. The peptones are present in the digestive mixture to the extent of only 1 per cent., while the acid is but 0·025 per cent, yet this quantity of peptones is sufficient not only to counteract the retarding influence of the acid, but increases the conversion of the starch to the extent of 7 per cent above the action of the saliva alone. Increasing the amount of peptones to 2 per cent does not appear to have any effect whatever, as the following results show:—

	1 grm. Peptones and 0·025 per cent Acid. Wt. Cu in one-tenth.	2 grms. Peptones and 0·025 per cent Acid. Wt. Cu in one-tenth.
1.	0·1060 grm.	0·1084 grm.
2.	0·0985 ,,	0·0974 ,,

In acid solutions of increased strength the peptones appear to exercise but slight if any influence; thus when the solution contained 0·1 per cent hydrochloric acid, no diastatic action at all was observed, even in the presence of the peptones. In 0·05 per cent acid solution, however, one-tenth of the diluted and mixed digestive fluid yielded 0·013 grm. Cu, showing a slightly increased action over and above what the acid fluid alone would give.

Control experiments with saliva, peptones, and acid without starch yielded negative results, thus showing that the saliva is entirely without action on the peptones in an acid solution of the above strength. Again, digestions of starch, peptones, and acid without saliva also gave negative results, proving that the peptones are wholly without diastatic action in the acid fluid. We deemed it advisable next to examine how far inorganic salts could influence the action of the ferment in an acid solution of the strength used. In aqueous solution it will be remembered the inorganic salts experimented with had but little or no action. In the acid solution the salts used were the same as before, viz., those present in the ash of the peptones. The experiments were conducted in the same manner as the preceding; 100 c.c. being the volume of the mixed fluid, of which 25 c.c. were filtered saliva, 25 c.c. water containing 1 grm. of starch, and 50 c.c. 0·05 per cent hydrochloric acid containing the salt.

FIRST EXPERIMENT.

	Wt. Cu in one-tenth. Grm.
Saliva and starch alone	0·0872
,, ,, +0·05 per cent HCl = 0·025 per cent	0·0088
,, ,, ,, ,, ,, +0·012 grm. NaCl	0·0132
,, ,, ,, ,, +0·012 grm. Na_2HPO_4	0·0120

SECOND EXPERIMENT.

	Wt Cu in one-tenth. Grm.
Saliva and starch alone	0·0835
,, ,, +0·05 per cent HCl = 0·025 per cent	0·0050
Saliva and starch, +0·05 per cent HCl + 0·012 grm. $CaHPO_4$	0·0079
Saliva and starch, +0·05 per cent HCl + 0·015 grm. $CaHPO_4$	0·0490
Saliva and starch, +0·05 per cent HCl + 0·024 grm. $CaHPO_4$	0·0600

It is thus evident that sodium chloride and phosphate when present to the extent of 0·012 per cent exercise but a very slight influence on the action of the saliva. Calcium phosphate, however, is seen to decidedly increase the diastatic action, though the amount contained in the peptones can have but little influence on the formation of sugar. Very striking is the great increase of sugar formed in the presence of 24 milligrms. of calcium phosphate. This result is certainly suggestive of a possible utility of the calcium phosphate invariably present in wheat, oats, and carbohydrate matter in general. What the exact explanation of the action of the phosphate in such a weak acid solution is of course hypothetical. The salt dissolves, in part at least, in the acid, and is thus probably modified with formation of bodies more favourable to the action of the ferment; it certainly cannot diminish to any extent the strength of the acid.

The influence of the combined inorganic matter of the peptones was now determined by experiment with the ash of No. 1, which contained 1·71 per cent.

	Saliva and Starch. Wt. Cu in one-tenth.	+0·05 per cent HCl. Wt. Cu in one-tenth.	+1 grm. Peptone. Wt. Cu in one-tenth.	+Ash 1 grm. Peptone. Wt. Cu in one-tenth.
1.	0·0866 grm.	0·0053 grm.	0·1058 grm.	0·0370 grm.
2.	0·0862 ,,	—	—	0·0123 ,,

Thus, in the sample containing the largest percentage of ash, and presumably therefore of calcium phosphate,

* Chittenden and Griswold, *American Chemical Journal*, 3, 313.
† Foster's *Journal of Physiology*, 3, 246.

and under the same conditions as this salt appears to work to the best advantage, only a slight increase is noticed in the diastatic action of the saliva. It is therefore evident that while the addition of 50 c.c. 0·05 per cent hydrochloric acid to an equal volume of saliva and water brings the diastatic action down almost to zero, the addition of 1 grm. of peptones to this acid fluid increases the diastatic action of the saliva to above its normal amount. In other words, the presence of 1 per cent of gastric peptones in a salivary mixture containing 0·025 per cent of acid acts as a stimulant to the diastatic ferment, causing it to act with greatly increased vigour. This fact appears to us to be of prime importance in solving the question as to the possibility of a continued action of the salivary ferment in the stomach. In 1881 one* of us, experimenting with human saliva, found that its diastatic action was increased by the presence of very minute quantities of hydrochloric acid; thus, while the quantity of sugar formed by freshly collected saliva was regarded as 100, the quantity formed by saliva of the same collecting in a mixture containing 0·005 per cent of hydrochloric acid was 110. Increasing the percentage of acid diminishes the diastatic action, until at last, when the fluid contains 0·025 per cent of hydrochloric acid, the formation of sugar is almost entirely stopped. Again, it was found† on digesting 25 c.c. of human saliva with 50 c.c. of gastric juice containing 0·2 per cent of hydrochloric acid, at 40° C. for two hours, that the diastatic ferment was entirely destroyed; likewise that simple warming of the saliva with 0·2 per cent acid at 40° C. for two hours was sufficient to destroy the greater part of the ferment, as was evinced by the low diastatic power of the neutralised fluid. Both of these results have received recent confirmation from the experiments of J. N. Langley‡ on the diastatic ferments of the parotid of rabbits. From his experiments he concludes that the ptyalin is destroyed by 0·2—0·04 per cent hydrochloric acid in from 7 to 24 hours at 40° C., and that the presence of 0·014 per cent of acid is sufficient to destroy all but the merest trace of ferment for five minutes at 39° C. It appears to us, however, that in the case of human saliva at least there may be in the presence of a very dilute acid a simple stopping of the diastatic action without destruction of the ferment; thus, in the presence of 0·025 per cent of acid there is but little diastatic action, but if that percentage of acid is sufficient to destroy the ferment in such a short time, in what manner does the 1 per cent of peptones in an acid solution of the same strength cause such an increased formation of sugar? Again, the experiments of Chittenden and Griswold showed that by warming a mixture of starch, saliva, and artificial gastric juice of weak acidity at 40° C. for 45 minutes, the diastatic action of the saliva was greatly increased; thus, in the digestion of 1 grm. of starch + 25 c.c. of water + 50 c.c. of gastric juice, containing 0·5 per cent hydrochloric acid + 25 c.c. saliva, the amount of sugar formed as compared with the amount found by the saliva alone was 133 : 100; while, as the present experiments show, the presence of 0·025 per cent hydrochloric acid alone stops the action almost completely. It therefore seems probable that in the presence of such dilute acids as the above the ferment is simply hindered in its action, the presence of the peptones being sufficient to counteract the retarding influence of the acid. That this view, as to the non-destruction of the ferment is correct, as regards human saliva at least, we think is plainly demonstrated by the following experiment. 75 c.c. of filtered saliva were divided into three equal parts, which were treated as follows:—

1st. 25 c.c. saliva +25 c.c. 0·05 per cent HCl warmed at 40° C. for 45 minutes. Solution then neutralised with Na_2CO_3. 1 grm. of starch made into a paste with 50 c.c. H_2O was then added and the mixture warmed at 40° C. for 45 minutes. Solution boiled and diluted to 500 c.c. 50 c.c. of this solution reduced 0·0862 grm. Cu.

2nd. 25 c.c. saliva +25 c.c. H_2O +50 c.c. 0·05 per cent HCl warmed at 40° C. for 45 minutes. Solution then neutralised with Na_2CO_3. 1 grm. of starch made into a paste with 25 c.c. H_2O was then added and the mixture warmed at 40° C. for 45 minutes. Solution boiled and diluted to 500 c.c. 50 c.c. of this solution reduced 0·0805 grm. Cu.

3rd. 25 c.c. saliva +75 c.c. H_2O warmed at 40° C. for 45 minutes. 1 grm of starch made into a paste with 25 c.c. H_2O was then added and the mixture warmed at 40° C. for 45 minutes. Solution boiled and diluted to 500 c.c. 50 c.c. of this solution reduced 0·0824 grm. Cu.

Here it is plainly seen that the ferment has not been in the least affected by the action of 0·025 per cent* hydrochloric acid at this temperature. In the case of 0·1 or 0·2 per cent acid the peptones are wholly without influence, since these strengths of acid are capable of destroying the ferment. It is evident that the salivary ferment is ultimately destroyed in the stomach by the gastric juice, but this fact does not necessarily preclude the possibility of a continued action of the saliva in the stomach. There is a growing impression that in the first stage of stomach digestion there is but little or no free acid present; thus Reinhard v. d. Velden† claims, as a result of observation, that for the first three-fourths of an hour after eating a hearty meal, human gastric juice fails to contain much if any free acid. It now seemed desirable to ascertain the rapidity with which starch is converted into sugar by the saliva. 125 c.c. of filtered saliva were thoroughly mixed, and 12 c.c. of this fluid were used in each experiment. The starchy solution was made by boiling 0·5 grm. of starch with 40 c.c. of water, and to this solution the 12 c.c. of saliva were added, making approximately 52 c.c. of fluid. The mixtures were kept at a temperature of 40° C. for the specified time, then boiled to destroy the ferment. Each fluid was then diluted to 200 c.c. and the sugar determined as before in 50 c.c. of the mixed and filtered solution. Following are the results:—

Period of digestion.	Wt. Cu in one-fourth.	Total amount of sugar.	Percentage of starch converted into sugar.
1 minute	0·0870 grm.	0·4425 grm.	39·82 per cent.
5 minutes	0·0963 ,,	0·4898 ,,	44·09 ,,
10 ,,	0·0991 ,,	0·5040 ,,	45·36 ,,
15 ,,	0·1005 ,,	0·5111 ,,	45·99 ,,
30 ,,	0·1040 ,,	0·5286 ,,	47·57 ,,
45 ,,	0·1087 ,,	0·5525 ,,	49 72 ,,
1 hour	0·1109 ,,	0·5637 ,,	50·73 ,,
2 hours	0·1147 ,,	0·5842 ,,	52·57 ,,

This experiment makes it very apparent that by far the greater part of the starch is almost immediately converted into sugar. It seems therefore quite possible, especially in view of the action of peptones in a weak acid solution, that in the case of human beings there may be a continuation of salivary digestion in the stomach, provided the contents of the stomach during the first stage of digestion do not contain more than 0·025 per cent of free acid.

Influence of Peptones in Alkaline Solution.

Previous experiments have demonstrated that the addition of sodium carbonate to saliva has a retarding influence on salivary digestion. It now seemed advisable to study the influence of peptones in the presence of dilute solutions of sodium carbonate, with especial reference to

* Chittenden and Griswold, *American Chemical Journal*, 3, 305.
† Chittenden and Griswold, *loc. cit.*
‡ Foster's *Journal of Physiology*, 3, 246.

* It should be mentioned here that the real percentage of acid is somewhat less than 0·025, owing to the slight alkalinity of the saliva. Ordinarily, however, the alkalinity is not so great in a sample of several hundred cubic centimetres as in a small quantity of freshly-secreted saliva. That there might be no possible chance of error, 25 c.c. of mixed saliva were carefully neutralised with diluted hydrochloric acid. Then 25 c.c. of 0·05 per cent HCl were added, making an exactly 0·025 per cent HCl solution. This mixture was then warmed at 40° C. for 45 minutes, after which it was exactly neutralised with Na_2CO_3 solution. 1 grm. of starch in 50 c.c. H_2O was then added and the whole warmed at 40° C. for 45 minutes; 50 c.c. or one-tenth of the diluted fluid yielded 0·0882 grm. Cu. Thus here, as in the above experiments, it is plainly evident, from the diastatic action of the neutralised saliva, that the ptyalin is not destroyed or even affected by 0·025 per cent of actual HCl under the above conditions.

† *Zeitsch ift f. physiolog. Chem.*, 3, 205.

the pancreatic ptyalin, for presumably in the intestinal canal the diastatic ferment there present acts on starch in an alkaline medium. 0·6 per cent, 0·3 per cent, and 0·1 per cent solutions of sodium carbonate were employed, experiments being tried with both starch and glycogen. 1 grm. of peptones was used in each case, and as this amount was dissolved in 50 c.c. of the dilute alkali, the digestive mixture of 100 c.c. contained approximately one-half the percentage of alkali employed. The following results were obtained:—

1.—With 0·6 per cent Na_2CO_3 and 1 grm. peptones.

	Saliva alone. Wt. Cu in one-tenth.	Saliva +50 c.c. Alkali. Wt. Cu in one-tenth.	Saliva, Alkali, and Peptones. Wt. Cu in one-tenth.
Starch	0·0905 grm.	0·0239 grm.	0·0456 grm.
,,	0·0904 ,,	0·0222 ,,	0·0486 ,,
,,	0·0835 ,,	0·0214 ,,	0·0515 ,,
Glycogen	0·1300 ,,	0·0312 ,,	0·0683 ,,

2.—With 0·3 per cent Na_2CO_3 and 1 grm. peptones.

	Saliva alone. Wt. Cu in one-tenth.	Saliva +50 c.c. Alkali. Wt. Cu in one-tenth.	Saliva, Alkali, and Peptones. Wt. Cu in one-tenth.
Starch	0·0904 grm.	0·0393 grm.	0·0685 grm.
,,	0·0835 ,,	0·0331 ,,	0·0710 ,,
Glycogen	0·1281 ,,	0·0423 ,,	0·1050 ,,

3.—With 0·1 per cent Na_2CO_3 and 1 grm. peptones.

	Saliva alone. Wt. Cu. in one-tenth.	Saliva +50 c.c. Alkali. Wt. Cu in one-tenth.	Saliva, Alkali, and Peptones. Wt. Cu in one-tenth.
Glycogen	0·1281 grm.	0·0908 grm.	0·1197 grm.

It becomes evident then from these experiments that in a solution containing either 0·3 per cent or 0·15 per cent of sodium carbonate, the presence of the peptones nearly doubles (quite and even more in the case of glycogen) the diastatic action, bringing it up almost to the action of the unaltered saliva. It may be questionable whether these experiments afford proof positive that the peptones stimulate the pancreatic ferment in the conversion of starch into sugar in the intestinal canal, but it is certainly proven that under such conditions as have been described here, the presence of 1 per cent of peptones in a 0·3 per cent sodium carbonate solution causes a greatly increased formation of sugar. Thus it seems probable that in the proteid and diastatic pancreatic digestion the formation of peptones, which must go on side by side with the formation of sugar, affords a decided aid to the latter process.

We next endeavoured to ascertain whether the salts already experimented with have any influence on diastatic action in alkaline solutions of the strength specified. The following experiments were tried:—

First Experiment.

	Wt. Cu in one-tenth. Grm.
Saliva and starch alone	0·0872
,, ,, +50 c.c. 0·6 per cent Na_2CO_3 = =3 per cent alkali	0·0220
Saliva and starch, +50 c.c. 0·6 per cent Na_2CO_3 + +0·012 grm. NaCl	0·0287
Saliva and starch, +50 c.c. 0·6 per cent Na_2CO_3 + +0·012 grm. Na_2HPO_4	0·0275

Second Experiment.

	Wt. Cu in one-tenth. Grm.
Saliva and starch alone	0·0844
,, ,, +50 c.c. 0·6 per cent Na_2CO_3 = =0·3 per cent alkali	0·0225
Saliva and starch, +50 c.c. 0·6 per cent Na_2CO_3 + +0·015 grm. $CaHPO_4$	0·0211
Saliva and starch, +50 c.c. 0·3 per cent Na_2CO_3 = =0·15 per cent alkali	0·0348
Saliva and starch, +50 c.c. 0·3 per cent Na_2CO_3 + +0·015 grm. $CaHPO_4$	0·0395

It is thus very evident that these salts have little or no influence on diastatic action, in alkaline solutions of the strength used. It next remained to try the influence of the ash of the peptones in alkaline solution. The ash of 1 grm. of peptones was employed, the experiment being conducted in the same manner as the preceding. The peptones used were those with 1·71 per cent of ash. Following are the results:—

	Wt. Cu in one-tenth. Grm.
Saliva and starch alone	0·0862
,, ,, +50 c.c. 0·6 per cent Na_2CO_3 = =0·3 per cent alkali	0·0216
Saliva and starch, +50 c.c. 0·6 per cent Na_2CO_3 + +ash 1 grm. peptone	0·0313
Saliva and starch, +50 c.c. 0·6 per cent Na_2CO_3 + 1 grm. peptone	0·0520
Saliva and starch, +50 c.c. 0·3 per cent Na_2CO_3 = =0·15 per cent alkali	0·0305
Saliva and starch, +50 c.c. 0·3 per cent Na_2CO_3 + +ash 1 grm. peptones	0·0400
Saliva and starch, +50 c.c. 0·3 per cent Na_2CO_3 + +1 grm. peptone	0·0740

We therefore deem it safe to conclude that the inorganic salts contained in the peptones play but an unimportant part in the stimulating action noticed in an alkaline solution of the strength specified.—*American Chemical Journal.*

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London, for the Month ending September 30th, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Right Honourable the President of the Local Government Board.

October 2nd, 1882.

Sir,—We submit herewith the results of our analyses of the 181 samples of water collected by us during the month of September, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 181 samples, one was recorded as very slightly turbid. The remaining 180 samples were found to be bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from Sept. 1st to Sept. 30th inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

Altogether, the results of our analyses of the 181 samples of water, examined by us during the past month, show a continuance of the excellent condition of the water supply of the Metropolis which we have remarked upon in our previous monthly reports.

As regards the systematic examination of the condition of aëration of the water, to which we attach great impor-

tance as an indication of its state of wholesomeness, we would observe that determinations of this condition are, at present, made and recorded only by ourselves.

As regards the determination of colour, we take it as beyond question that the method of examination employed and originated by ourselves, however susceptible it may be of further improvement, is far more trustworthy and accurate than the rough method heretofore, and still, made use of by chemists in general.

As regards the determination of turbidity, we cannot advance any special claim on behalf of the admittedly rough and imperfect method of examination employed by ourselves in common with other chemists. It is, however, satisfactory for us to find that our results, in respect to the habitual freedom from turbidity of the water, are thoroughly in accordance with those of the official Water Examiner, Colonel Bolton. Moreover, any defects, in regard either to colour or turbidity of the water supplied to the public are matters that come necessarily within the immediate cognisance of the public.

We have the honour to remain, Sir,
Your obedient Servants,

William Crookes,
William Odling,
C. Meymott Tidy.

THE PATENT VACUUM-PUMP REFRIGERATOR AND ICE-MACHINE.

On the 13th inst. a number of scientific gentlemen met at the premises of the Aylesbury Dairy Company, 31, St. Petersburg Place, Bayswater, to witness the action of a machine which is, we believe, destined, from a twofold point of view, to open up a new epoch in chemical industry, and which is eminently deserving of the attention of manufacturers, capitalists, as well as of men of science.

The more immediate object of the invention is the production of ice, the refrigeration of water, &c. This purpose it effects more conveniently, simply, and cheaply than any arrangement hitherto known. We need scarcely remind our readers that in modern manufacturing chemistry, no less than in the refined operations of the laboratory, a complete command of temperature is necessary. High temperatures have been always easily producible, but to keep up a low temperature on the large scale and for any required time has been a troublesome and expensive matter. There are not a few refrigerating machines in existence, but these depend for their action on the evaporation of certain volatile liquids, such as ammonia, sulphurous anhydride, ether, methyl chloride, carbon disulphide, &c. To all these and to analogous agents there are grave practical objections. The first outlay is considerable, their recovery and condensation involve much cost and inconvenience, especially in hot climates or seasons where a refrigerating machine is most needed. If even a trace of these volatile chemicals escapes there results either damage to the machinery, injury to the health of the workmen, or deterioration of the product.

In the machine in question the refrigeration is effected simply by the evaporation of water under a special vacuum-pump, by which the pressure of the air is reduced, if desired, even down to ½ millimetre ($=\frac{1}{1520}$ atmosphere), a more perfect vacuum than has heretofore been obtained on an industrial scale. In ice-making a considerably less perfect vacuum (say 4 millimetres absolute pressure, or $\frac{1}{190}$ atmosphere) is found sufficient. The only chemical required in the process is sulphuric acid, which is not dissipated or evaporated, and never comes in contact with the refrigerating part of the machine. Hence it neither requires renewal nor occasions injury.

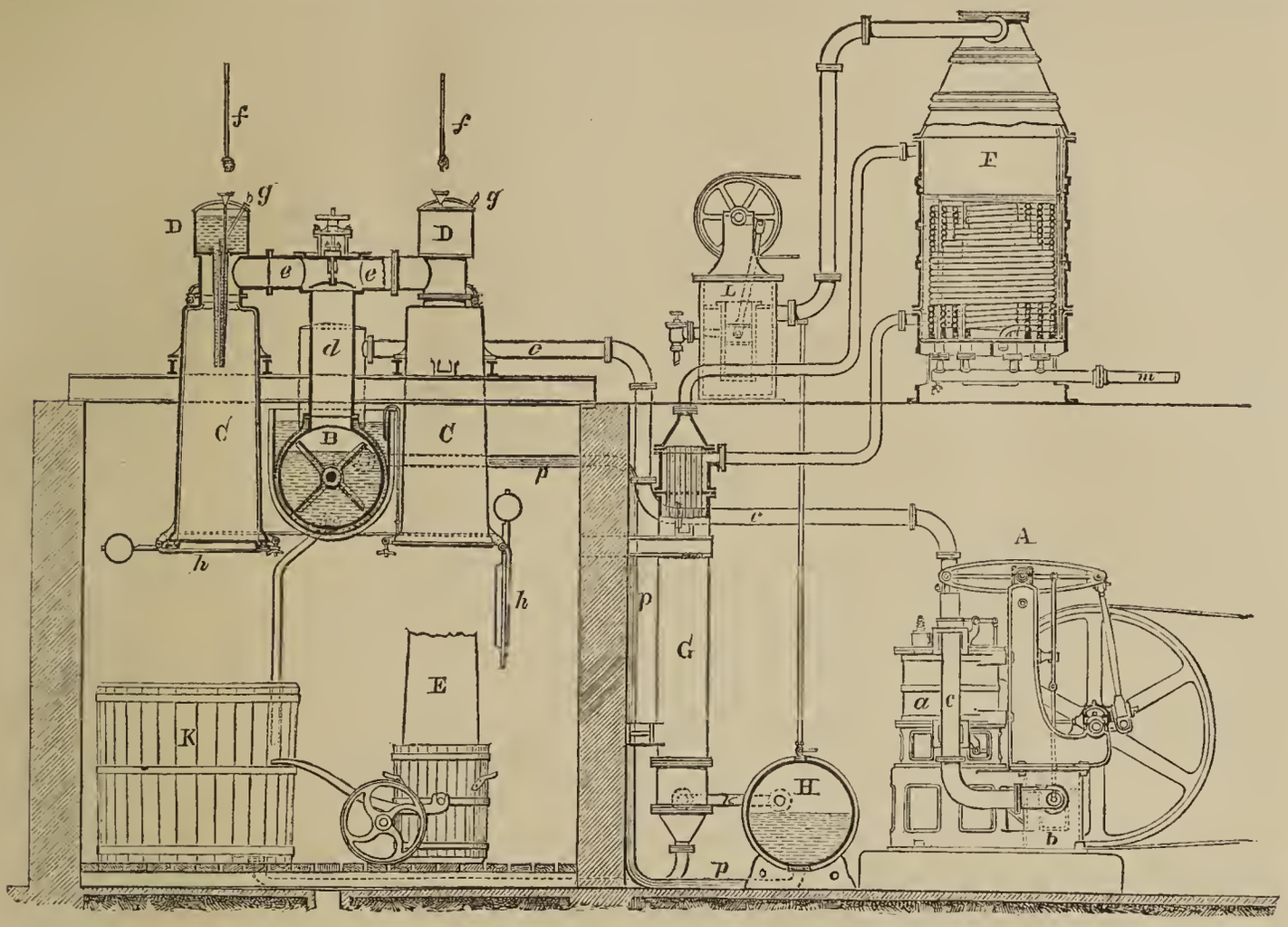
The construction and action of the machine will be more easily understood by reference to the accompanying figure. The working of the process will be found strikingly economical. A machine which turns out 12 tons of ice per twenty-four hours requires only one man at a time to work it, and for the production of this quantity rather less than a ton of coal—or, more exactly, 180 lbs. per ton of ice—is consumed. There is no need for any large supply of water for cooling—a very important point on board ship and in countries where water is scarce. The average power needed for working a single machine does not exceed 3 h.-p., and taking all expenses into account, with interest on capital and 10 per cent for depreciation, the cost of the ice will not exceed 3d. (threepence) per cwt.

The scope for such a machine is simply immense. In addition to the production of ice,—now the subject of an extensive commerce,—we may briefly mention the transportation of meat, game, fish, milk, vegetables, &c., to any desired market from the most distant parts of the world. It is found that this may be effected by means of cold air far more safely and with less injury to the flavour, digestibility, and nutritive value of the articles than by any other means. Further, the command of a low temperature, effected, *e.g.*, by ice-cold water conveyed in pipes traversing the liquid, is of great value in the cooling of worts, in regulating the fermentation of beer and of wine in hot localities, in the manufacture of chocolate, where too high a temperature is very injurious. Certain double decompositions can further be effected best at a low temperature. Thus, under Fournier's patent a mixture of brine and of the lixivium of alum-shales yields at a little below freezing-point crystals of Glauber's salt, whilst aluminium chloride (useful as a disinfectant and in the destruction of vegetable matter mixed with wool) remains in solution. Magnesium chloride is obtained in like manner by refrigerating brine mixed with the mother-liquor of salt-marshes.

In the new or ammonia-process of alkali-making which is now coming to the front the solution of common salt employed when saturated with ammonia generates much heat, and requires to be cooled by a refrigerating apparatus. In the preparation of certain tin mordants, such especially as the so-called "bowl-spirits," it is in hot weather necessary to be able to regulate the temperature. In the preservation of albumen refrigeration is of capital importance during its purification.

The manufactures of nitroglycerin, gun-cotton, and all analogous bodies also require convenient and powerful means of refrigeration. The mixture of sulphuric and nitric acids must be cooled after mixture, and when it comes to act upon the glycerin, cotton, &c., a rise of temperature is apt to deteriorate the product, if not to occasion positive danger. In all these manufacturing processes, and in others which might be found upon a prolonged search, the Vacuum Ice-Machine and Refrigerator must, from its economy, simplicity, and freedom from objectionable features, fairly claim the attention of manufacturers.

There is still a second phase in the invention, perhaps of not less importance. The vacuum-pump may be used not for refrigeration or the production of ice, but wherever it is required to boil, concentrate, or distil any liquid, paste, &c., under reduced atmospheric pressure, or as far as possible in the total absence of air. Perhaps the first case in which boiling *in vacuo* was introduced is the manufacture of sugar. On prolonged heating even at temperatures not exceeding 212° F., a part of the sugar is converted into glucose containing more or less caramel, and forming the liquid known as treacle or molasses, a substance of much less commercial value than pure cane-sugar. The more the atmospheric pressure on the surface of the liquid is reduced the lower is the temperature at which its water evaporates and the smaller is the proportion of sugar converted into treacle. The principle of boiling under reduced pressure is equally applicable in the manufacture of jams or preserved fruits (now an important industry), of extracts of dye-woods, extracts of meat; or medicinal woods, barks, &c. In all these cases, as a rule



A.—Vacuum-pump. *a*, large cylinder; *b*, small cylinder; *c*, suction pipe from pump to absorber and freezing cylinders.
B.—The absorber, containing sulphuric acid, which is kept in motion by revolving arms, a vacuum being maintained. *d* and *e*, pipes connecting absorber with ice cylinders, the connection between *d* and *e* being controlled by valve at top of *d*.
C.—The cylinders in which the ice is formed.
D.—Vessels into which the water to be frozen first passes from the pipe *f*, before flowing into the cylinders, through the valve controlled by the lever *g*; *h* the lid or bottom of the ice cylinder which is opened so as to allow the ice to fall out.
E.—Block of ice.
F.—The concentrator, in which the acid is freed from the vapours absorbed during the passage of the water from D to C.
G.—Exchange apparatus through which the dilute acid ascends
H. to be concentrated and the concentrated acid descends to the store tank H, from which it can be drawn by the vacuum into the absorber as required. In the exchange apparatus the boiling concentrated acid is cooled during its descent by passing over and outside the pipes through which the cold dilute acid is descending.
K.—Tank into which the acid is received from the absorber after it has become diluted, and from which it is drawn into the concentrator.
L.—Small vacuum-pump for maintaining vacuum in the concentrator. *k*, pipe conveying concentrated acid to store-tank H.
m.—Steam pipe from boiler.
p.—Connection pipe between absorber and store tank H.

the product is more or less injured in colour, flavour, &c., by prolonged heating in presence of atmospheric oxygen. The more such oxygen is withdrawn and the atmospheric pressure reduced so as to allow of extraction at a lower temperature, the purer and the finer is the product.

There are also many substances which require to be dried, but which cannot well be exposed to heat without risk of deterioration. We may here mention explosives, and textile goods dyed with such colours as safflower. By means of the vacuum-pump such articles can be dried without any application of heat, and consequently without any risk of fire or deterioration.

In fractional distillation, as in the separation of the different coal-tar products, and more especially in the case of the heavier hydrocarbons, the use of a vacuum has a great future before it. According to Professor Lunge "excellent success" has been obtained in this matter in the separation of anthracen oil. In like manner glycerin can be advantageously purified by distillation under reduced pressure. Albumen will also be improved in quality by evaporation *in vacuo*. In all these cases the new pump, giving as we have already remarked a more perfect vacuum than has ever been obtained before, will be found a marked improvement.

We learn that the machine set up on the premises of the Aylesbury Dairy Company will be available for experiments whether of a scientific or of an industrial character, and may be viewed on written application.

The Institute of Chemistry.—The first Provincial Dinner of the Institute of Chemistry was held at the Western Hotel, Birmingham, on Friday, the 20th inst., and was numerously attended both by members residing in and around this busy centre of chemical industry and by members from London. In replying to the toast of the evening, "Success to the Institute," proposed by Prof. Odling, the President, Prof. Abel, briefly traced its history. It was established to supply the want keenly felt by the chemical platform of an organisation to protect their interests. Its fundamental objects were the promotion of a thorough study of chemistry and the adoption of whatever measures might be necessary to advance the interests of the profession. A suitable course of training had been laid down after careful consideration, and the attainment of the grade of Member or Associate was gradually coming to be regarded as a proof of fitness for election to technical, professional, or official appointments. On Friday and Saturday the members visited Earl Dudley's Iron Works, Messrs. Chance's Alkali and Glass Works, The Mint, Gas Works, &c.

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. XI.

Communicated by J. W. MALLET,
Professor of General and Applied Chemistry in the University.

(76.) *On Arsenic Pentiodide.* By B. E. SLOAN, of Charleston, South Carolina.

A former student in this laboratory, Mr. Hampton, having ascertained the existence of a pentiodide of phosphorus and examined its chief properties,* Mr. Sloan undertook the attempt to produce a corresponding compound of arsenic, which if obtained would have connected with it the interest of additional evidence as to the true pentad character of this latter element. Mr. Sloan had previously endeavoured to prepare a pentachloride,† but without success.

635 parts of iodine and 75 of metallic arsenic ($=AsI_5$) were enclosed in a tube from which air had been expelled by carbon dioxide gas, sealed up, and exposed, surrounded by an iron tube to secure uniformity of temperature, to 150° C. for an hour and a half. After slow cooling the tube was opened, and found to contain a garnet-brown crystalline mass with resinous lustre. Under the microscope this mass seemed to be homogeneous, and, although the crystalline form could not be distinctly made out, some of the facets exposed were suggestive of elongated prisms of monoclinic character. The substance fused at 70° C., and was more or less soluble in water, alcohol, chloroform, ether, and carbon disulphide. Disintegration and change of appearance soon took place on exposure to moist air, the colour becoming lighter and more orange. A rough determination of specific gravity, made upon a small fragment of the mass coated with paraffin, gave as result 3·93. This may be too low, yet it is worthy of notice that the specific gravity of arsenic tri-iodide has also been found lower than that of either of its constituents, though to a less extent than in the experiment now quoted,‡ and the lowering of density observed as the result of combination of 1 at. arsenic with 3 of iodine will, if extended by calculation in the ratio 3 : 5, give just the result found by Mr. Sloan.

A specimen of the supposed pentiodide was sealed up in an atmosphere of nitrogen in a glass tube, and the end containing the solid material was heated to about 200° C. The mass fused and boiled, deep reddish brown vapour was given off, and successive rings of deposit formed in the cooler part of the tube, that nearest the heated end having apparently the same character as the residual mass, while iodine had separated at the further end. After boiling for three minutes, on cooling and breaking the tube the residual mass was analysed, and afforded 632 pts. of iodine for 75 of arsenic; it hence had still essentially the composition of the pentiodide.

A new specimen was prepared, with a very small excess of arsenic over the theoretical amount (for AsI_5), and, having been sealed up in nitrogen as before, was gradually heated in one end of the tube to 100° C., the other end being kept at about 20°. At 70°, the fusing-point of the compound, there was slight evolution of iodine vapour, but after seven hours at 100° only a trifling amount of iodine had been driven off, and had condensed in the cooler end of the tube. Dissociation was found to increase rapidly with further rise of temperature.

Iodine and arsenic were then fused together in other proportions, one lot containing 762 parts of iodine for 75 parts of arsenic ($=As+I_6$), and another 889 of iodine for the same amount of arsenic ($=As+I_7$), and samples of the resulting products were heated in sealed tubes containing inert gases. A sample of the former was heated in a mercury bath at 190° for two and a half hours; the residual mass was found to contain 619·5 of iodine for 75 of arsenic. Another specimen of the same was kept for five hours at 190°: dissociation occurred to such an extent as to bring the amount of iodine in the residual mass down to 430 for 75 of arsenic. In this latter case the residual mass was seen under the microscope to consist of a mixture of the tri-iodide crystals with crystals, apparently unaltered, of the brown supposed pentiodide, distinguishable where thin enough by difference of behaviour in polarised light. In these two experiments it was noticed that iodine was expelled much more rapidly at first than afterwards.

Two other samples, one each of the samples having the composition $As+I_6$ and $As+I_7$ respectively, were heated for forty-five minutes only to 190°. The residual portions gave on analysis 639 and 641 of iodine for 75 of arsenic, agreeing very fairly with the formula AsI_5, and thus showing that the iodine in excess of five atoms is lost much more readily than the two other atoms to be removed in reduction to AsI_3.

A specimen of the tri-iodide itself was prepared, with even a slight excess of arsenic, and on being heated to 165° C. in a closed tube, it too was found to undergo gradual dissociation, losing iodine to an increasing extent with increasing temperature, though much less so than the supposed pentiodide.

In the hope of securing individual crystals of the pentiodide, a solution of this substance in carbon disulphide was allowed to evaporate at atmospheric temperature in a desiccator. Only ruby-red crystals, which on analysis were found to consist of AsI_3, mixed on further evaporation with crystals of iodine, were obtained. The pentiodide seems, therefore, to be decomposed by mere solution in carbon disulphide. This conclusion was confirmed by examining the absorption-spectrum of the solution, which was found to agree simply with the superposed spectra of separate solutions of arsenic tri-iodide and free iodine.* Like decomposition occurs on dissolving in ether: on passing dry ammonia into the solution, the white precipitate characteristic of the presence of the tri-iodide† is thrown down, the supernatant liquid remaining coloured by iodine.

It is remarkable that the fusing-point of the substance under notice was found to be close to 70° C., while the tri-iodide fused at 119°, and iodine itself fuses at 114°. No other proportions of iodine and arsenic gave a fusing-point as low as 70°.

It seems fair to conclude that arsenic, as well as phosphorus, is capable of forming a true, though unstable, pentiodide, which is broken up by sufficient rise of temperature and by solution at least in certain liquids. It adds another illustration to the remarks of Professor Williamson on changes of atomic value under varying conditions of temperature, in his address to the Chemical Section of the British Association in 1881.‡

(77.) *On the Solubility of Iodine in Arsenic Trichloride.* By B. E. SLOAN.

Having failed to prepare a compound of one atom of arsenic with five atoms of chlorine, but obtained one with five atoms of iodine, Mr. Sloan also tried to form an intermediate products containing both halogens by bringing together iodine and arsenic trichloride. No evidence could be obtained of combination in definite proportions, but the iodine was found to dissolve in the liquid chloride of arsenic when heated in sealed tubes, colouring it deeply, the amount taken up increasing rapidly with rise of temperature, and the surplus iodine separating out in

* CHEMICAL NEWS, vol. xlii., p. 180.
† *Ibid.*, vol. xliv., p. 203.
‡ Bödeker (Die Bezichungen zwischen Dicht und Zusammensetzung bei festen und liquiden Stoffen, Leipzig, 1860, 26) found the sp. gr. of $AsI_3=4·39$, while that of As = 5·75, and of I = 4·95, all in the solid state.

* See the application of this method to distinguishing mixture from chemical combination by Krüss—*Berichte d. Deutsch. Chem. Gesellsch.*, xv., 1243
† Bamberger and Philipp, *Ibid.*, xiv, 2643.
‡ As reported in CHEMICAL NEWS, vol. xliv., p. 127.

large crystals on cooling. By using a large excess of iodine at first, stopping the cooling at different points of temperature, drawing off samples of the remaining solution, and decomposing these by an aqueous solution of sodium sulphite, determinations were made of the iodine, chlorine, and arsenic present, leading to the following results:—

100 parts of $AsCl_3$ at 0° C. dissolve 8·42 parts of iodine.
" " 15 " 11·88 " "
" " 96 " 36·89 " "

(78.) *On attempts to produce Compounds of Carbon Tetrachloride with Hydrochloric Acid and with other Compounds of the Halogens.* By W. H. SEAMON, of Wheeling, West Virginia.

A passage in Mendelejeff's well-known paper on the "Periodic Law" of the chemical elements, to the effect that, while silicon tetrachloride combines with other chlorides and forms moderately stable bodies, the corresponding chloride of carbon does not seem to be capable of doing so, and that this remarkable difference deserves to be carefully studied, led to Mr. Seamon spending a good deal of time in attempts to obtain some evidence of such combining power on the part of the latter chloride. All, however, led to but negative results.

Pure carbon tetrachloride was treated with a current of pure, dry hydrochloric acid gas under atmospheric pressure and at various temperatures down to −20° C., definite portions of the liquid being afterwards decomposed by an alcoholic solution of potash, and the chlorine determined. Experiments of the same kind were also made with hydriodic acid. Potassium chloride and ammonium chloride, moreover, were placed with carbon tetrachloride in sealed tubes, and exposed to various temperatures, from −20° to +338° C., and the liquid afterwards examined. In no case was any evidence of combination observed, and the analytical results simply corresponded to the unaltered tetrachloride.

In Hannay's experiments on the limit of the liquid state,* very great pressure, extending up to more than 140 atmospheres, produced absorption of hydrogen gas by carbon tetrachloride, but it is said that "several bodies were formed by the action of the hydrogen, the action being capable of being pushed so far as to form chloroform." Hence it may have been that no compound of an atom of carbon with more than four other atoms was formed, but that hydrogen in part displaced chlorine, hydrochloric acid, or less probably chlorine, being formed and liquefied, or reduced to very dense gaseous form, under the pressure used.

(79.) *Analysis of Allanite of Unusual Chemical Composition, from Bedford Co., Virginia.* By W. T. PAGE, of Norfolk, Virginia.

The specimen examined formed a compact black mass, with pitch like lustre, and light grey streak. Hardness = nearly 7. Sp. gr. = 4·32. Fusible before the blowpipe flame with intumescence. Completely decomposed by hydrochloric acid, forming a jelly. Analysis gave—

SiO_2	26·70
Al_2O_3	6·34
Ce_2O_3	33·76
Di_2O_3	16·34
La_2O_3	1·03
Fe_2O_3	3·21
FeO	4·76
MnO	trace
BeO	0·52
MgO	0·54
CaO	2·80
Na_2O	0·49
K_2O	0·55
H_2O	1·99
	99·03

* *Proceedings of the Royal Society*, No. 218, 319 (March 10, 1881).

Excluding the water as unessential, these figures agree well with the ortho-silicate formula—

$$\left\{\tfrac{4}{11}(M''+M'_2)+\tfrac{2}{11}M'''\right\}SiO_4.$$

If beryllia be counted as Be_2O_3, there is not quite so close agreement with the formula—

$$\left\{\tfrac{3}{9}(M''+M'_2)+\tfrac{1}{9}M'''\right\}SiO_4.$$

The very large proportion of the cerium metals present, their oxides forming over 50 per cent of the whole mineral, or more than double the usual amount, and the large relative quantity of didymium as compared with lanthanum, are remarkable peculiarities in the composition of this mineral, and almost seem to justify its being considered at least a distinct variety. The ratio between the dyad and triad bases is quite different from that of ordinary allanite.

(80.) *Analysis of Helvite from near Amelia Courthouse, Virginia.* By B. E. SLOAN.

This rare mineral was identified by Prof. H. C. Lewis among the interesting contents of the granite vein worked for mica at the locality in question, and an analysis by Mr. R. Haines has been published.* The analyst remarks, however, that his material contained more than 9 per cent of gangue, that after subtracting this the results do not agree with those for helvite from the original European locality, and that a further investigation is desirable. A sufficient amount of the mineral from this State was obtained from Prof. Fontaine, of the University of Virginia, to admit of quite pure material being picked out for an analysis by Mr. Sloan.

The mineral was in fragile masses showing imperfect tetrahedral crystals. Colour wax to lemon yellow, with very pale lemon-yellow streak. Lustre vitreous. Translucent. Hardness = 6. Specific gravity = 3·25. Fusible before the blowpipe flame, with intumescence. Decomposed by hydrochloric acid, with formation of gelatinous silicic acid, and liberation of sulphuretted hydrogen. The analysis gave—

SiO_2	31·42
BeO	10·97
MnO	40·56
FeO	2·99
Al_2O_3	0·36
Mn	8·59
S	4·9
	99·88

If beryllium be taken as dyad, and the small quantity of aluminum be neglected, these figures lead nearly to the formula adopted by Rammelsberg—

$$3M''_2SiO_4+MnS,$$

or more accurately to—

$$10M''_2SiO_4+3MnS.$$

If beryllium be taken as triad, this will become—

$$10(\tfrac{6}{7}M''+\tfrac{1}{7}M''')SiO_4+3MnS.$$

If the sulphur be viewed as replacing oxygen, a disilicate formula would be indicated, but none can be calculated to accord well with the above figures.

(81.) *Analysis of Garnet from the same locality (near Amelia C.H., Va.).* By W. H. SEAMON.

This mineral was pale hyacinth-red, with colourless streak. Lustre vitreous. Transparent in small fragments. Hardness = 6·5. Sp. gr. = 4·27. Analysis gave—

SiO_2	32·83
Al_2O_3	16·69
MnO	41·80
FeO	8·15
Loss on ignition	0·61
	100·08

* *Proc. Acad. Nat. Sci. Philadelphia*, 1882, 100.

Leading approximately to the general garnet formula, but with a deficiency of triad as compared with dyad metals, which would suggest that the iron or manganese, or both, occur in the former instead of the latter condition. Mr. Seamon, however, believed that he correctly determined these metals as exclusively in the state of ferrous and manganous silicates, and it is observable that the other recorded analyses* of this variety of garnet—spessartite, or aluminum-manganese garnet—from other localities agree in presenting the same anomaly.

(To be continued.)

CORRESPONDENCE.

SAFETY CHEQUES.

To the Editor of the Chemical News.

Sir,—There are three little fragments of old-fashioned wisdom which our inventors and improvers would do well to bear in mind. The first of these is to let well alone and not to insist on gilding refined gold. The second is to count the cost of a process. In experimenting upon the small scale amateurs, especially, are apt entirely to overlook every item of outlay except the mere cost of materials. They forget that every additional manipulation when we come to work upon an industrial scale increases and often doubles the cost of labour, of supervision, and in addition the chances of misadventure. The third consideration is that success, if too dearly bought, differs little from failure.

Of these principles I have been strongly reminded of late by a certain proposed method of obtaining cheques which cannot be tampered with before presentation. The reader will remember that in the beginning of last year you noticed an invention by Mr. A. Anthony Nesbit, F.C.S., which effects this object in a manner which combines certainty with simplicity and economy. Ordinary paper which requires no special manufacture is tinted with neutral litmus, with eosine, or with any other colour capable of being modified both by acids and alkalies, but in different manners. Upon this the inventor prints with a dilute acid producing red characters, lines, or other devices. By again printing with an alkaline liquid he produces blue lines, &c., interwoven with the first. The cheque is then ready for use, and is absolutely impregnable.

A Mr. Nowlan, however, forgetting the three principles above laid down, has obtained a patent for a much more complicated method of attaining the same end. He takes two or more pieces of thin paper, prints one side of each with pigments or reagents partly permanent and partly alterable, and then pastes them together with the printed side inwards, so that the devices, designs, or letters have to be read *through* the paper.

I have never had the pleasure of seeing one of these compound cheques, but even assuming that it affords absolute security against fraudulent alterations, it is merely on a level in this respect with Mr. Nesbit's cheque, whilst the trouble and expense of working under Mr. Nowlan's system must be two or three times as great. Instead of printing one piece of paper, two or three have to be operated upon, each with a different design or part of a design, and have then to be cemented neatly and accurately together without smudging any of the alterable pigments and making them run!

Surely there is no room for any practical man to ask which invention will prove the cheaper and the more convenient. Mr. Nowlan may reach his end, but it is by a cumbrous and round-about method.—I am, &c.,

Calico-Printer.

* Compare analyses by Seybert, Rammelsberg, d'Ohsson, Lissenko, and Klaproth, quoted in Dana's "System of Mineralogy."

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
July 20, 1882.

Contributions to the Industry of Vanadium.—G. Witz and F. Osmond.—The authors notice the presence of vanadium in many ores of iron. The vanadic acid is eliminated along with phosphoric acid, and is concentrated, especially in the slags of the Thomas and Gilchrist process. These slags in some cases contain 1·92 vanadic acid = 1·08 per cent metallic vanadium. They have observed that the vanadiferous slags, simply treated with hydrochloric acid, are successfully used in calico printing instead of pure vanadic salts, the foreign matter present not interfering.

Certain Compounds of Tetratomic Elements.—Albert Colson.—Already noticed.

Specific Heat of Gaseous Acetic Acid.—MM. Berthelot and Ogier.—Already noticed.

Nitrogenous Colloids.—E. Grimaux.—The author remarks the excessive difficulty of defining what is meant by the proteic (albumenoid and collagenous) bodies, since their function is unknown. The definitions of these bodies found in text-books are merely based upon the totality of their physical properties. Their molecular weights are unknown, and it is uncertain whether the bodies isolated, such as albumen and fibrine, are true chemical individuals or merely mixtures. M. Grimaux proposes to define them as follows:—The proteic matters are nitrogenous colloids, which are split up by hydratation into carbonic acid, ammonia, and amidic acid. Beyond this definition there is nothing precise; the coloured reactions do not belong to the albumenoid molecule, but depend on the various groups which enter their constitution. The red colour developed by Millon's reagent indicates a residue of the tyrosine group; the blue-violet colouration given by copper sulphate and potassa belongs equally to aspartic anhydride and to biuret.

Volumetric Determination of Phenol.—T. Chandelon.—The author uses a standard solution of potassium hypobromite, prepared as follows:—Dissolve 14 to 15 grms. of pure caustic potassa in 1 litre of water, and add about 10 grms. bromine in small quantities, stirring frequently. There is produced a golden-yellow liquid, which is diluted so that 50 c.c. may correspond to a 10 c.c. of a normal solution of phenol at 10·5 per cent, that is, to 0·05 grm. pure phenol. This liquid should be put into a blackened bottle and kept in a cold place. The determination is then effected as follows:—50 c.c. of the hypobromite solution are put in a Berlin ware capsule, and the solution of phenol is dropped in from a burette, stirring all the time, until the mixture is decolourised. After this point is reached, it is sufficient to add a few more drops of the phenol solution until the liquid loses the property of turning blue, a drop of iodised starch paste laid on a porcelain plate. The percentage is then found by dividing the figure 5 by the number of c.c. which have been employed.

Deutsch-Amerikanische Apotheker Zeitung.
Vol. iii., No. 12, September 1, 1882.

Volumetric Determination of Phenol.—The process depends on the precipitation of phenol by bromine as tribrom-phenol. Solutions of phenol of known strength are prepared by means of weighed quantities of pure phenol, and these solutions are dropped into a measured quantity of dilute bromine water until all the bromine is combined.

For the recognition of this point the author utilises a solution of starch containing some potassium iodide, which is placed upon a porcelain plate in small drops. As long as free bromine is present a drop added to the starch liquor gives the usual blue colouration, but as soon as all the bromine is taken up the colour no longer appears.

Journal für Praktische Chemie.
New Series. Vol. xxvi, Nos. 12, 13, and 14.

Occurrence of Lactic Acid in Morbid Urine and the Oxidation in the Tissues of the Leukæmic.—M. Nencki and N. Sieber.—Not suitable for abstraction.

MISCELLANEOUS.

Sewage Treatment.—An Agricultural and Horticultural Show open for all produce grown solely with the Native Guano obtained from the sewage of Aylesbury took place on the 19th inst. The numerous and distinguished visitors were much gratified both with the successful purification of the sewage, the entire freedom from nuisance throughout the works, and the fine display of vegetables and fruits exhibited. We could not help asking ourselves why, at sanitary gatherings, among the sentiments proposed and applauded we never hear the name of Dr. George Walker, once known as "Church-yard Walker"—the true father of modern sanitary reform? *Sic vos non vobis!*

Researches on the Specific Volumes of Liquid Compounds.—This treatise, which extends to upwards of 100 pages, consists of a general introduction by W. Lossen, and a special research on the specific volumes of certain allyl, propyl, and allied compounds, by A. Zander. The latter chemist concludes that the specific volume of the allyl compounds is decidedly greater than results if it is calculated from the specific volumes of the normal propyl compounds of analogous composition.—*Liebig's Annalen.*

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Estimation of Caustic Soda.—Can any correspondent recommend a rapid technical method of estimating small quantities of caustic soda in presence of carbonate and sulphide of sodium? The "phenacetolin" recently recommended does not answer, as far as we have tried it.—G. S.

MEETINGS FOR THE WEEK.

THURSDAY, Nov. 2nd.—Chemical, 8. "On some Halogen Compounds of Acetylene," by Dr. R. T. Plimpton. "On Dihydroxy-benzoic Acids and Iodo-salicylic Acids," by Dr. A. K. Miller. "Crystalline Molecular Compounds of Naphthalene and Benzene with Antimony Chloride," by Watson Smith and G. W. Davis. "Additional Evidence that Quinoline belongs to the Aromatic Series of Organic Substances," by Watson Smith and G. W. Davis. "On Orcin and some of the other Dioxy-toluols," by R. H. C. Nevile and Dr. A. Winther.

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ALEX. MOORE, C.A.,
Secretary.

Glasgow, 128, Hope Street,
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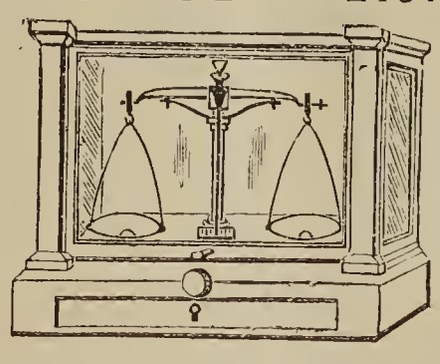

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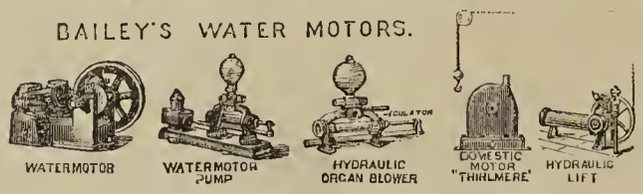

Silver Medal, Manchester, 1879; *Blackburn*, 1881.

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THE CHEMICAL NEWS.

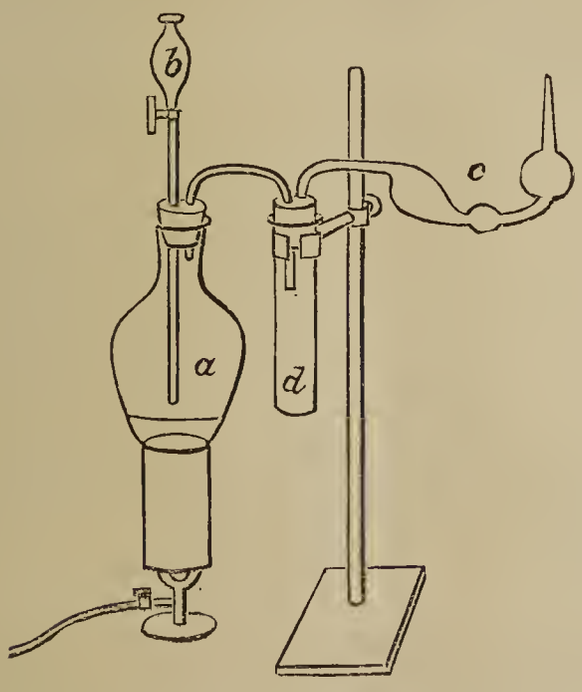
Vol. XLVI. No. 1197.

ESTIMATION OF SULPHUR IN IRON AND STEEL.

By GEORGE CRAIG.

For well nigh two years I have been estimating sulphur in iron and steel by a modification of the evolution process, which consists in passing the evolved gases through an ammoniacal solution of peroxide of hydrogen; which oxidises the sulphuretted hydrogen to sulphuric acid, which latter is estimated as usual. The *modus operandi* is as follows:—

100 grains of the iron or steel are placed in the 10 oz. flask (*a*) along with ½ oz. water; 1½ ozs. hydrochloric acid are added from the stoppered funnel (*b*) in such quantities at a time as to produce a moderate evolution of gas through the nitrogen bulb (*c*), which contains ⅛ oz. (20 vols.) peroxide of hydrogen and ½ oz. ammonia. The tube (*d*) is to condense the bulk of the hydrochloric acid which distils over during the operation. When all the acid has been added and the evolution of gas becomes sluggish, heat is applied and the liquid boiled till all action ceases. Air is blown through the apparatus for a few minutes and the contents of *c* and *d* washed into a small beaker and acidified with hydrochloric acid, boiled, barium chloride added, and the barium sulphate filtered off after standing a short time. A blank experiment must be done with each new lot of peroxide of hydrogen obtained, which always gives under 0·1 barium sulphate with me.



The whole operation is finished within two hours, the usual oxidation process occupying nearly two days; and the results obtained are invariably slightly higher than by the oxidation processes.

Until lately I have always added excess of chlorate of potash to the residue left in (*a*), evaporated it nearly to dryness, diluted, filtered and added chloride of barium to the diluted filtrate, but only once have I obtained a trace of precipitate after standing 48 hours, and the pig-iron in that case contained 8 per cent of silicon, so that all the sulphur is evolved during the process. It has been objected to the evolution process that when the iron contains copper all the sulphur is not evolved, but theoretically it ought to be evolved whether copper is present or not; and to test the point I fused 3 lbs. of ordinary Scotch pig-iron with some copper for half-an-hour in a Fletcher's gas furnace. No copper could be detected in the iron by mere observation with a microscope, but it gave on analysis 0·225 per cent of copper, and on estimating the sulphur in it by the above process and by oxidation with chlorate of potash and hydrochloric acid, using 100 grains in each case, and performing blank experiments, I found:—

By peroxide of hydrogen process .. 0·0357 per cent.
By oxidation ($KClO_3$ and HCl) ,, .. 0·0302 ,,

so that even in highly cupriferous pig-iron all the sulphur is evolved on treatment with strong hydrochloric acid.

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ON THE COLOURING MATTER (RUBERINE) AND THE ALKALOID (AGARYTHRINE) CONTAINED IN *AGARICUS RUBER*.

By Dr. T. L. PHIPSON, F.C.S., &c.

Agaricus ruber (*A. sanguineus*) is a poisonous fungus well known to botanists. It is perfectly described by Kickx in his "Flore Cryptogamique des Environs de Louvain," and by Chevallier ("Flore des Env. de Paris," tome i.), &c. I have found it growing profusely in the pine woods of the Hampshire coast, especially in the neighbourhood of Bournemouth, during the latter part of September and whole of October. It is readily distinguished by its burning taste, and its *purple-red* colour, which not only covers the pileus, but frequently coats a considerable part of the thick solid stipe, and is very different from the bright scarlet of *A. muscarius* and *A. Cæsarius*.

This colouring-matter of *A. ruber*, for which I propose the name of Ruberine, is exceedingly interesting, both from an optical and a chemical point of view. It may be remembered that, a few years ago, I described under the name of Palmelline, a beautiful red colouring-matter extracted from *Palmella cruenta* (*Chaos sanguinea*), an account of which was published in the Chemical News.

This substance was remarkable, among other things, by its solutions showing a vivid *yellow fluorescence*, and by their giving dark absorption-bands in the *yellow* portion of the spectrum. Seen by transmitted light, palmelline is a beautiful *rose-red*, but by reflection it is *yellow*. The colouring-matter of *A. ruber* is no less remarkable in this respect. It is also a beautiful *rose-red* (very similar to palmelline) when seen by transmitted light, but it presents a very vivid *blue fluorescence*, and gives in its spectrum two wide and dark absorption-bands in the *green*.

Ruberine is soluble in water and in alcohol. A strong solution cuts off all the lower portion of the spectrum from the beginning of the green; but a weaker solution only shows the two very characteristic dark bands in the green part of the spectrum. Both the aqueous and alcoholic solutions present this character. These solutions are *rose-red* by transmission and *blue* by reflection. Their fluorescence, like that of palmelline solutions, is quite as marked (if not more so) as that of quinine or of esculine.

Several authors say that *A. ruber* is often found with its pileus more or less eaten "by insects." For a considerable time I could not discover what kind of animals eat this fungus, and suspected, from the extensiveness of the ravages, that some birds fed upon it. However, doubt in this respect was dispelled by discovering that the markings were due to slugs. Several of these mollusca I found feeding upon *A. ruber* at night and early morning, and always on the summit of the pileus. The stipe and

lamellæ were always respected. The slugs eat through the colouring-matter and go to a certain depth into the substance of the fungus, but soon return to continue feeding on the coloured surface.

Fries, the great Swedish botanist, was right when he said that the taste of *A. ruber* is *at first bitter*, and then hot and pungent, like pepper. Whatever portion of the fungus is bitten gives at first a distinctly bitter taste, which is soon followed by a burning sensation, like that of pepper, and remaining some time upon the tongue. It is like the taste of aconitine, but not so intense.

All authors agree in stating that this fungus is extremely poisonous. The taste being due apparently to an alkaloid, I endeavoured to isolate this substance, and though the method I give below is very imperfect, it suffices to bring to light certain facts which appear to me rather interesting.

About 100 grms. of the freshly gathered fungus, from which the skin containing the purple-red colouring-matter had been removed as much as possible, were left for forty-eight hours in water acidulated by 8 per cent of hydrochloric acid. The solution, filtered and neutralised with a slight excess of carbonate of soda, was shaken up with ether. On evaporation, the ether left the alkaloid in the form of a white, or yellowish white, amorphous substance, somewhat greasy in aspect, having a distinctly bitter taste followed by a burning sensation on the tongue, a slight odour *sui generis*, easily fusible into pale yellow globules, and volatile with an odour recalling that of quinoleine. It dissolves in alcohol and ether, and slowly but *completely in dilute hydrochloric acid* (in the cold). The *sulphate* appears to be quite *insoluble in water*, but dissolves in alcohol. With *nitric acid* the acid solutions take a *rose-red* colour, and the same occurs with *chloride of lime*, with soon bleaches it. Also when, as above, the ether is shaken up with the liquid, air gets entangled and ozonified, acting on the alkaloid, which it transforms into this red colouring-matter, producing a thin red layer between the ether and the solution, so that some alkaloid is thus lost. With bichromate of potash and an acid solution of the alkaloid there is no reaction in the cold.

From these and other observations, too long to relate here, it appears to me very probable that the colouring-matter of *A. ruber* is formed from the alkaloid at those points of the fungus which are at the same time in contact with the *air* and the *solar rays*, *i.e.*, the upper surface of the pileus and a good portion of the stipe. Also that both the alkaloid and colouring-matter belong to the aromatic series.

I propose for this alkaloid the name of *Agarythrine*, as it is well characterised by the red tint produced, as just stated, by nitric acid and hypochlorite of lime, as well as by its taste, which reminds us of aconitine, the insolubility of its sulphate in water, &c.

Ruberine being very easily soluble in water, it often happens that heavy rains of some days' duration wash it completely out of the head of the fungus, which then presents a peculiar bleached appearance.

London, October 31, 1882.

PYROLOGICAL NOTES.

By Lieut-Colonel W. A. ROSS, late R.A.

II. On a New Blowpipe Reagent.

In the year 1880 Mr. Charles Griffin, of Garrick Street, was so kind as to obtain, at my request, absolutely pure boric and phosphoric acids from Germany. The latter, although very carefully sealed in a stoppered bottle, arrived in a semi-fluid state, and as it became quite fluid before the blowpipe, and dropped off the platinum wire, I found it impossible to make a bead of it. The so-called "glacial phosphoric acid" appears to be an extremely acid hydrated sodium (sometimes ammonium) phosphate, containing about 15 per cent of soda, but exhibiting only acid reactions with oxides, &c., before the blowpipe.

(1.) I dissolved about two ounces of the pure phosphoric acid in distilled water, and digested in it, over a sandbath at a temperature just under boiling-point, pure crystallised boric acid, until, long before the former was saturated, crystals began to form; crystallisation proceeded rapidly after it had once commenced.*

(2.) I then poured off the superfluous liquor, and dried the crystals by placing the evaporating dish containing them vertically at side of the fire; when they seemed to lose crystallisation water, and to become earth-like, of a greyish white colour.

(3.) Before the blowpipe, this earth-like matter adheres to a hot platinum wire ring, swells out like the mineral Apophyllite, becomes perfectly white, and finally fuses to a clear transparent bead, which possesses double refraction in the polariscope.

(4.) It gives a reddish blue colour with cobalt oxide, P.P.,† and a very dark blue in H.P.

(5.) The hot bead sticks for some time, even to the aluminium tray underneath, when dropped. Shows that it retains heat.

(6.) The transparent bead becomes crystalline, opaque, and white, after treatment in H.P.; that is, after hydrogen from the hydrocarbonous pyrocone has been absorbed by it; it is again rendered transparent by a few seconds treatment in P.P.

(7.) Pyrochrome (coloured flame), brown-orange in O.P.; pale green-yellow in H.P.

(8.) In a long P.P., *i.e.*, one inch from the tip of the blue, the bead becomes very fluid and drops off the wire (the reverse of every other known blowpipe flux); shows that it retains a large proportion of water?

(9.) A trace of CuO gives the bead a fine blue-green colour, even after H.P., with which it is impossible to produce the red opaque Cu_2O (proves a high oxidising power; retaining all its O., even in H.P.).

(10.) After slight H.P. on the transparent, pure bead, crystals, apparently in the hexagonal (rhombohedral) system, form over the surface as seen under a ¼ inch objective.

(*a*.) After long H.P. these crystals increase to such an extent that the bead becomes opaque, white, and shows a pink colouration on cooling (from the sulphur of the gas).

(*b*.) After powerful H.P. from a foot blower—which renders the bead nearly white-hot, and transparent on cooling—and then a gentle H.P. as above, which then caused superficial crystals only, quite a different kind of crystallisation is apparently induced in the interior of the bead, in the shape of large solid crystals, showing modifications between a hexagon and tetrahedron; the lower side, apparently, remaining hexagonal.

(11.) In re-heating this bead in O.P., it suddenly fell off the wire on to an agate slab, and immediately drew itself up from an oblate spheroid into an almost perfect sphere.

(To be continued.)

Industrial Richness of Raw Alunite in Powder.—P. Guyot.—The alunite of La Tolfa is not uniformly rich in alumina and potassium sulphate. Crystalline specimens may contain as much as 32 per cent of alumina, whilst in other portions the alumina may sink to 17·5. The part which is most easily pulverised is the richest in utilisable matter.—*Comptes Rendus.*

* I have just separated from the "mother-liquor," and dried on blotting-paper, some of these crystals, after standing for two years in a press. They seem flat, transparent, and shapeless like pieces of mica. They are evidently not in the least deliquescent.

† P.P.=peroxidising pyrocone; when the bead is held half an inch from the tip of the blue pyrocone, O.P. is at the point, H.P. inside the blue.

THE NEW ANALYSIS OF THE BUXTON THERMAL WATER.

By J. C. THRESH, D.Sc.

THERE are many things in connection with the subject of mineral springs which modern science cannot be said to have satisfactorily explained or incontestably proved, and many others which formerly were enveloped in mystery, that have been found to admit of exceedingly simple explanations. The origin of the various mineral and gaseous constituents has always been a point of considerable interest, and has given rise at different times to a good deal of speculation. Many minds are so constituted that theorising and mental speculation have greater power of fascination, and are far more interesting to them than the process of probing nature by experiment to ascertain the truth. Imagination is as useful, and almost as necessary, to the man of science, as to the artist or poet, and the success with which he interrogates Dame Nature depends in a very great measure upon his ability to conceive methods by which he may directly or indirectly worm from her her treasured secrets; but it is always advisable, however, to make as certain as possible that our speculative structures are founded on facts, otherwise the most elaborately constructed fabric may suddenly tumble to the ground, and the reputation of the builder suffer in the general wreck. Thus the cause of the ascent of water in springs, the source of the heat, and of the constant temperature in thermal springs, are matters of considerable interest; but with regard to the famed waters of Buxton, that which has provoked most discussion, and most theorising, has been the attempt to explain in a satisfactory manner the origin or source of the immense amount of gas said to be contained in it, the constant temperature, and never-failing flow. Very little investigation is required to prove that the springs have been in existence from time immemorial, and that from the day on which the first thermometer was immersed in it until now, there has been no variation in its temperature—81·5° F. Observations taken as to the length of time required to fill the baths and reservoirs prove that in summer and winter, in dry weather and in continued wet, the flow is always the same. The nature of the gaseous and of most of the mineral constituents has been long ago ascertained with tolerable certainty; but that the gases should be present in such inexplicable quantities, as has been asserted by more than one chemist of repute, certainly required most positive confirmation. That some blunder had been committed seemed very probable, and the careful perusal of the only report at all entering into details, at once proved that such was the case; therefore, two winters ago, a series of experiments was instituted in order to arrive at the exact truth. But this investigation had not proceeded far before it was discovered that many things of importance in connection with the water had hitherto been entirely overlooked, consequently a complete and exhaustive examination of the whole subject was determined upon. The analytical results obtained, together with details of the analyses, were communicated to the Chemical Society, and a brief resumé of the whole will be given here in a more popular form, preceded, however, by a still more brief account of the results obtained by chemists who had previously examined the water, acknowledging our indebtedness for much of this information to Dr. Robertson's "Guide to Buxton and the Peak of Derbyshire."

Between the years 1733 and 1783 the thermal water appears to have been four times examined. The first analysis was made by Dr. Short, who found that each gallon contained 26 grains of solid matter, 13 grains being carbonate of lime, and the remainder "marine salt" and "nitre" in equal proportions. This very meagre and indefinite information was not increased by the two following investigators, but the fourth, Dr. Higgins, gave a much more satisfactory account of his labours. He found in the imperial gallon—

Sea salt (sodium chloride) ..	4·6 grains.
Calcareous earth, combined with acidulous gas (calcium carbonate)	15·1 ,,
Sulphate of calcium	2·0 ,,
Chloride of magnesium	1·6 ,,
Iron, combined with acidulous gas (carbonate of iron)	0·6 ,,
Total	23·9

Although this is the first analysis worthy of the name, no mention is made of the gaseous constituents, but the defect was remedied two years later by Dr. Pearson, who published his results in a work entitled, "Observations and Experiments for Investigating the Chemical History of the Tepid Springs of Buxton." This book is chiefly remarkable for containing an account of the first attempt to examine and estimate the gaseous elements. He found each gallon to contain one-fourteenth of its volume of what he termed "permanent vapour." His examination of the saline matter was much more imperfect than that of Dr. Higgins, since he only detected three constituents, and overlooked others, the presence of which the latter gentleman had demonstrated. This defective work is the more singular since he gives an accurate account of the physical properties of the water, and otherwise proves himself to have been a painstaking and careful observer. He obtained less than 20 grains of solid matter from the gallon, and says that it consisted of—

Chloride of sodium	2⅓ grains.
Sulphate of lime	3⅓ ,,
Carbonate of lime	14 ,,
Total	19⅔ ,,

The next analysis in chronological order is that made by Sir C. Scudamore and Mr. Garden in 1819, after an interval of thirty-five years, during which the science of chemistry had progressed with giant strides. The existence of a number of "permanent vapours" had been demonstrated, many new elements and compounds had been discovered, and the old method of analysis had been vastly improved upon. It is not surprising, therefore, that these chemists added much to our stock of knowledge. The gas dissolved in the water they found consisted of two permanent vapours, which they identified as nitrogen and carbonic acid gas, and these they determined as exactly as they were then able. They found in an imperial gallon—

Magnesium chloride	0·773 grains.
Sodium	3·200 ,,
Calcium sulphate	0·800 ,,
,, carbonate	13·866 ,,
Extractive matter	0·666 ,
Loss	0·693
	19·998

Out of the 20 grains of saline matter they were only able satisfactorily to account for 18½, and in so far their work is defective; but their account of the result obtained by the actual analysis of the gaseous constituents is of more importance, as will afterwards appear. In the same volume of water they found—

Free carbonic acid gas ..	2·00 cubic inches.
Nitrogen	6·18 ,,

For thirty-three years the waters remain untroubled by the chemist; but at the expiration of that period Buxton had begun to flourish, all the sciences were advancing with unexampled rapidity, and it was thought advisable that one of the greatest chemists of the day should submit its waters to a searching examination, using large quantities of it for the purpose. A full account of the result of the analysis, executed in 1852 by Prof. Playfair at the School of Mines, London, at the request of the Duke of Devonshire's agent, will be found in the guide previously mentioned. The work bears every evidence of

most conscientious care, but is chiefly remarkable on account of a most singular mistake made by him in calculating the amount of nitrogen contained in the water. For the first time the gas evolved at the spring was quantitatively examined, proving it to be nearly pure nitrogen. One hundred volumes were found to contain, as mean of two experiments—

Carbonic acid gas	1·167
Nitrogen	98·833

and one gallon of water—

Silica	0·666 grains.
Oxide of iron and alumina ..	0·240 ,,
Carbonate of lime	7·773 ,,
Sulphate of lime	2·323 ,,
Carbonate of magnesia	4·543 ,,
Chloride of magnesium	0·114 ,,
,, sodium	2·420 ,,
,, potassium	2·500 ,,
Fluoride of calcium	trace ,,
Phosphate of lime	,, ,,
	20·579 ,,

He does not tabulate in the same way the gaseous constituents, but states that he found 3·47 c. inches of carbonic acid gas, and assumes the volume of nitrogen in same quantity of water (one gallon), to be 206 inches.

Carbonic acid	3·47
Nitrogen	206

It will be noticed that whilst Pearson estimated the gaseous constituents at one-fourteenth the volume of the water, or about 19 cubic inches, Scudamore and Garden at 8¼ cubic inches, three-fourths of which were nitrogen, Playfair assumes the presence of 209·47 cubic inches, of which 206 are nitrogen. The word *assumes* is written advisedly, for this analyst never attempted to estimate the nitrogen directly or by actual experiment, and never asserted positively that so much is present, but in an altogether erroneous manner calculates the quantity from his analysis of the evolved gas, and gives in his report as the reason "that there was no *very* accurate method for ascertaining the precise quantity of this gas in the water." The ground for this assumption shall also be given in his own words:—

"Judging from the analysis (*i.e.*, of the gas evolved at the spring) and the proportion of the gases, it is *assumed* that at the moment of issue, the water is charged with 206 cubic inches of nitrogen and 15·66 cubic inches of carbonic acid. This *assumption* is founded upon the proportional relation of the two gases. The proportion of carbonic acid in the water being determined, and the proportion of carbonic acid to that of nitrogen contained in the water being 1·2 to 98·8, the amount of nitrogen contained in the water at the moment of issue may *fairly be assumed* to be 206 cubic inches per gallon."

As before remarked, in no part of the report does he affirm that so much gas is dissolved in the water, and in asserting that "the proportion of carbonic acid to that of nitrogen contained in the water is as 1·2 to 98·8," he is really assuming the very thing he is trying to prove. For unless he could prove the presence of this amount of nitrogen, how could he logically assert that the two gases were present in the above ratio. Moreover, after all these assumptions, an error is made in a simple calculation, for $\frac{3{\cdot}47 \times 98{\cdot}8}{1{\cdot}2}$ is 286, and not 206. This may, however, be a printer's error.

Unfortunately Dr. Playfair was entirely in the wrong when he took for granted that the gases existed in solution in the same proportion as in the free evolved gas, for he entirely overlooked the well known fact of the great difference in the solubility of the two gases. Carbonic acid gas dissolves under the normal pressure and temperature in about an equal volume of water, whilst nitrogen requires from 60 to 70 volumes for its solution. If, therefore, we take an excess of a mixture of these gases in any proportion and treat it with water so as to cause absorption, it follows that the gas absorbed will be richer in the more soluble constituent than the portion remaining undissolved. Moreover, he must have been perfectly familiar with the law enunciated by Henry at the beginning of this century, and known as "Dalton's Law of Partial Pressures," from which it was possible to calculate from the composition of the evolved gas that of the gas dissolved. When the proportion and quantity of carbonic acid and nitrogen in the Buxton Thermal Water are calculated from the result of Playfair's analysis of the gas bubbling up at the spring, the results are very near the truth, as recently ascertained by direct experiment.

Whilst with truth remarking that the nitrogen could only be present in the water in solution and not in combination, and that there was not then known any "very accurate method of ascertaining the precise quantity of the gas," yet the utter impossibility of the water containing in solution any such quantity of gas, as he assumes, never for a moment suggests itself to his mind. Otherwise he would have ascertained by some sufficiently approximate manner of direct experiment whether such really could be the case. We feel that here we are in the presence of a psychological phenomenon, which we willingly leave to the students of that science to explain.

In 1860, Dr. Muspratt, of Liverpool, published the result of an analysis of the water, without giving any details, or even mentioning by what process he determined the gases. As he found less saline matter in the gallon than any chemist either before or since, and affirms the presence of nearly twice as much nitrogen as Playfair had assumed, we should not be justified in attaching any great degree of importance to his conclusions. Whilst Playfair appears to have been perfectly unconscious of the impossibility of his assumption being correct, Muspratt indirectly acknowledges the absurdity of his statement; for, in his "Dictionary of Chemistry," after giving as the result of his analysis, that one gallon of Thermal Water contained—

Carbonic acid	3·5 cubic inches
Nitrogen	504·0 ,,

He adds, "Dr. Robertson, in treating of the physical character of the Buxton waters, ascribes their brilliancy, when drawn, to the gas held in solution. Of course this must be fallacious, for very little gas is held in solution or dissolved." He first asserts that the water contains a large quantity of gas, then says very little gas is in solution. Finally, he proceeds to speculate on the origin of the nitrogen, and discusses what he terms "so unnatural a phenomenon." Strange to say, he never attempts to explain in what condition the gas did exist in the water, if not in solution; and, in contradiction to Playfair's statement, that "the nitrogen in the water could only be present in solution," he simply makes the affirmation that "very little gas is in solution." Truly an instructive example of scientific work and method, and of what he would probably call an "unnatural phenomenon." Possibly he may have regarded the whole thing as supernatural, and therefore incapable of proof or of substantiation by experiment; for without attempting such he proceeds to show how hypothesis after hypothesis *cannot even be conceived* capable of affording a scientific explanation of it. The exercise of much less ingenuity and very little trouble would have enabled him to come at the truth.

The result of the analysis of the saline constituents is subjoined. It differs somewhat considerably from Playfair's, but from the internal evidence alone, and we have nothing else in this case to judge from, there is no reason to assume that it was incorrect. (See next column).

In 1876 a London analyst, Mr. O. Hehner, who had been visiting here, and became interested in the waters, made an analysis of the residue left on evaporation, hoping, by aid of the recently discovered and exceedingly delicate method of spectrum analysis, to detect some constituents which possibly had been previously overlooked,

	Grains per gallon.
Carbonate of lime	8·541
,, magnesia	3·741
,, protoxide of iron	0·082
Sulphate of lime	0·330
Chloride of calcium	1·227
,, magnesium	0·463
,, sodium	2·405
,, potassium	0·260
Silica	1·044
Nitric acid	trace
Organic matter	0·341
Fluoride of calcium	trace
Phosphate of lime	trace
	18·434

By this means he detected a trace of lithia: he also ascertained the presence of manganese, and affirmed that in small quantity he had found iodine. Playfair had carefully sought for this element, but failed to detect a trace; and in the course of the analysis, finally to be referred to, negative results were alone obtained in searching for it, although the saline residue from a large quantity of water was employed. As also will be shown in the sequel, a number of elements were overlooked which the spectroscope is capable of detecting. Some correspondence followed the publication of the letter containing Mr. Hehner's results. A London physician, and a constant visitor to Buxton, contending that such an incomplete analysis, making no mention whatever of the gaseous constituents, was misleading, and ought never to have seen the light.

In the subjoined analysis, the results are expressed to the nearest third decimal place. In the original it is carried out to the fifth, giving it, as his critic remarked, "a sufficiently pretentious appearance."

Chloride of sodium	4·517
Sulphate of soda	0·202
,, potash	0·669
,, ammonia	0·016
,, lime	0·674
Nitrate of lime	0·257
Carbonate of lime	9·186
,, magnesia	4·727
,, iron	0·037
,, manganese	0·008
Silica	0·838
	21·131
Phosphoric acid	a trace
Iodine	,,
Lithia	,,

It will be noted that fluorine was not detected, and that nitrates are stated to be present. The correctness of this latter statement is doubtful; most certainly no such quantity was present when the water was last examined, nor when Playfair analysed it. The existence of such an amount of nitric acid in a deep well of water of such a character, and so organically pure, required confirmation.

The last analysis made of the Buxton thermal water occupied most of the writer's leisure during the winters of 1880-81 and 1881-82. Residing upon the spot, and with a laboratory within a very short distance, unusual facilities were enjoyed for making a prolonged and searching chemical investigation. The reason why the work was undertaken has already been given. The complete examination necessitated three series of analyses; the first, of the mud deposited near the mouth of the spring; the second, of the gas issuing from the spring, and of the gas dissolved in the water; and third, of the saline constituents.

Every thermal water deposits more or less rapidly upon cooling, or from loss of carbonic acid gas or exposure to the air, a mud or sinter, differing in appearance and in composition according to the character of the strata through which the waters pass in their subterranean journeyings. Very frequently the examination of such deposits reveals the presence of elements which on account of their excessively slight solubility are present in the water in such minute quantities that their presence may be overlooked in an analysis of the water itself.

When the springs and reservoirs into which the water flows were examined, the slabs, walls, &c., were found to be coated with a very dark brown mud which stained the skin when rubbed between the fingers and thumb. It appeared of a peculiar character, and it was felt that its analysis could not but yield interesting results. Such proved to be the case. It was found to consist chiefly of the higher oxides of manganese in a hydrated condition, and capable of combining with oxygen when exposed to the air, or to water containing oxygen in solution. In composition it corresponds closely with that of many samples of psilomelane and wad, ores of manganese. The importance of the inference to be drawn from this discovery will be discussed later on. The following elements were in appreciable quantities, the first three being afterwards detected in the water:—Barium, strontium, lead, molybdenum, copper, cobalt, and zinc. Molybdenum has never before been discovered either in a mineral water or in a deposit from such a spring, but probably is derived from a molybdate of lead which may frequently be found in cavities of limestone rocks. The tabulated result of the analysis is appended.

Oxide of manganese	80·32
Sulphate of barium, sand, &c., ...	1·08
Lead oxide	0·15
Copper ,, ...	0·07
Molybdic acid	0·02
Cobalt oxide	0·30
Iron and aluminium oxides	1·36
Zinc oxide	0·46
Barium oxide	0·79
Calcium ,, ...	5·31
Strontium ,, ...	a trace
Magnesium ,, ...	3·18
Carbon dioxide	3·23
Phosphoric acid	0·01
Water	3·93
	100·21

The results obtained by the analysis of the gas evolved at the spring were in close accordance with those of Dr. Playfair, but it was noted that the composition of this gas varied slightly, according to the length of time during which it was allowed to remain in contact with the water under the reduced pressure to which it is subject when it has risen to the earth's surface. Thus the mean of two analyses of the gas collected at the mouth of the spring and at once removed from contact with water, gave—

Nitrogen	99·12
Carbonic acid	0·88

whilst some of the gas which had been allowed to stand over a little water gave—

Nitrogen	98·63
Carbonic acid	1·37

This difference would be inexplicable were Dr. Playfair's assumption correct. Undoubtedly at some little depth the free gas consists of pure nitrogen, whilst at a still greater depth even that will be in solution.

In determining the amount and composition of the gas held in solution by the water at the moment of issue from the springs, the greatest care was taken to obtain reliable and accurate results, and as an appendix to the original paper an illustrated description will be found of the apparatus used in collecting and measuring the gases. The mean of a number of experiments gave the following results:—

	Cubic inches per gallon of water.
Nitrogen	6·1
Carbonic acid gas	4·1
Total	10·2

From this the calculated percentage composition is—

Nitrogen	59·78
Carbonic acid gas	40·22
	100·00

To dissolve 10·2 cubic inches of such a gaseous mixture at a temperature of 81·5° F. (that of the thermal water) would require a pressure of 1·64 atmospheres; consequently on exposing the freshly drawn water bubbles of free gas commence to make their appearance, and after a time the excess passes off, but this takes place, if the water is not agitated, much more slowly than might be anticipated, considering the insoluble character of the gas. In fact when the water is agitated as in bathing, the surplus gas is liberated almost instantaneously and in bubbles so minute that the water becomes opalescent. Doubtless much of the gas is liberated within the very pores of the skin during bathing, and acts in what may be considered its semi-nascent state, producing effects altogether anattainable by use of the same agent in any other condition.

The analysis of the mineral constituents was conducted after the manner of Baron Bunsen, in his examination of the mineral springs of Baden-Baden. The process, though exceedingly tedious, leaves nothing to be desired as regards the accuracy of the results, and has the advantage over older methods in allowing these results to be so completely checked that there is little danger of overlooking any of the constituents. As was previously stated the whole of the elements present in the deposit were not found in the residue obtained by evaporation of large quantities of the water, but this was doubtless owing to their almost entire insolubility, and to our ignorance of reactions sufficiently delicate to detect such minute quantities. Calculated into grains per gallon, the water was estimated to contain—

Bicarbonate of calcium	14·01
,, magnesium	6·02
,, iron	0·03
,, manganese	0·03
Sulphate of barium	0·05
,, calcium	0·26
,, potassium	0·62
,, sodium	0·84
Nitrate of sodium	0·03
Chloride of calcium	0·02
Chloride of sodium	3·10
,, ammonium	trace
,, magnesium	0·95
Silicic acid	0·95
Organic matter	0·02
Carbon dioxide	0·20
Nitrogen	0·19
	27·32
Lithium, strontium, lead, and phosphoric acid	traces.

From this analysis, or rather from the manner in which the results are expressed, it would appear as if the quantity of saline matter per gallon was much in excess of that found by any other observer; but this difference is only apparent, and arises from the fact that the compounds represented by them as carbonates are found here as bicarbonates. The carbonates of calcium, magnesium, iron, and manganese are practically insoluble in water, but in the presence of carbonic acid the bicarbonates are formed and these dissolve. Upon evaporating a water containing such salts, they are decomposed, the carbonic acid being given off and an insoluble carbonate remaining. This decomposition is readily seen when a little of the Buxton Thermal Water is boiled in a glass flask. Hence, whilst the last analysis represents, as nearly as can be ascertained, the composition of the saline matter as it exists in the water, the former ones merely represent the result of the analysis of the water residue.

The further comparison of the various analyses, and of the Buxton Thermal Waters with those of other localities, must be reserved for a future paper, as must also the discussion of the inferences to be drawn from analysis, as to the origin of the gases, and the source of the constant heat, and of other subjects of a similar character admitting of the freer use of the speculative faculty.

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. XI.

Communicated by J. W. MALLET,
Professor of General and Applied Chemistry in the University.

(Continued from p. 196.)

(82.) *Analysis of Beautifully Crystallised Albite from the same locality (near Amelia C.H., Va.).* By R. N. Musgrave, of Baykin's Depôt, Virginia.

This mineral occurs in fine large masses of beautifully clear, colourless, flattened crystals, delicately aggregated, so that the mass as a whole is easily shattered. Hardness = 6. Sp. gr. = 2·605. Analysis gave—

SiO_2	68·44
Al_2O_3	19·35
Na_2O	11·67
K_2O	0·43
	99·89

Corresponding very accurately with the tri-silicate formula—

$$NaAlSi_3O_8.$$

(83.) *Examination of a supposed Metallic Meteorite found in Augusta Co., Virginia.* By W. H. Seamon.

The specimen in question, received from Mr. W. B. Alexander, of Waynesboro', Va., was a rough, pear-shaped mass of metallic iron, weighing about 1¼ kilogrammes, covered with an oxidised crust of varying thickness, up to 13 millimetres. The iron was of pretty uniform gray colour, and fine granular fracture, and did not exhibit Widmanstätten figures on being treated with acid; it was spongy, and penetrated throughout by more or less oxide. Sp. gr. of the whole mass, including the crust, = 5·76. An analysis of as solid a portion of the interior of the mass as could be obtained gave—

Fe	90·45
Mn	0·10
C	0·19
S	0·15
P	0·37
SiO_2	4·18
Al_2O_3	0·49
CaO	2·16
O, and loss	1·91
	100·00

The silica did not appear to be gritty, and dissolved almost entirely on boiling with a solution of sodium carbonate. Nickel and cobalt were carefully tested for, but were not present.

It is pretty clear that this specimen, although looking

much like a meteorite. and found in the same county in which form masses (three of them large) of genuine meteoric iron have been found,* is of terrestrial and artificial origin—in all probability the remains of a mass produced in one of the early "bloomery" fires of this part of the country.

(84.) *On Metallic Iron accompanying Native Gold in Montgomery Co., Virginia.* By W. T. Page.

In examining some of the gold† obtained by alluvial washing in the bed of Brush Creek in the part of this State referred to, it was noticed that certain dark coloured grains were attracted by the magnet, and were malleable, and on sweeping with a magnet a considerable quantity of the "concentrated" sand from which this gold had come, and picking over with the aid of a lens the portion which had been attracted and removed, a good many such grains were secured, of various sizes, the largest weighing from 60 to 80 milligrms., while the smallest were almost dust; the average weight of those collected was about 5 m.grms. Some of the grains were rounded, but many appeared as flattened scales, often twisted as if taken off by a planing or lathe, and with rough ragged edges. They were but slightly oxidised on the surface. Sp. gr., taken on a very small quantity, = 7·20. Analysis gave—

Fe	97·12
Cu	0·04
S	1·47
Quartz	0·82
	99·45

The absence of carbon, phosphorus, nickel, cobalt, tin, and manganese was proved.

Investigation at the locality from which the gold came showed that no tools were used at the washings except picks and shovels, and that no mechanical work of any kind is now, or has ever been, done at a higher level in the valley of Brush Creek which might have led to the distribution of particles of iron. The grains of iron obtained, both from their shapes and the size of some of them, were quite unlike what one might expect to find detached from such tools as picks and shovels in their ordinary use. The probability seems very strong that we have here a case of the occurrence of terrestrial native iron, and from the amount found in the small parcels of gold and auriferous sand examined, these grains must be pretty extensively distributed, and must exist in the aggregrate in considerable quantity. Such occurrence of native iron along with gold has been previously reported. Thus Molnar mentions it as found in the auriferous sand of Ohlapian, in Transylvania,‡ and Genth has examined fragments of it, the largest of which was half an inch long, occurring in (on ?) the bed rock of the gold placers of Camp Creek, Montana, under six feet of gravel, and associated with native lead.§

(85.) *Examination of similar Grains of Metallic Iron accompanying Native Gold in Burke Co., North Carolina.* By W. T. Page.

The detection of native iron under the circumstances just described led to an examination for it of a parcel of auriferous sand ("concentrates") from Burke Co., N. Carolina, the bulk of the sand consisting of zircon, monazite, magnetite, &c. Malleable metallic grains were found, quite like those from the Virginia sand, many of them irregular, twisted, and ragged, weighing from 113 m.grms. down to 0·2 m.grm.; average weight about 7 m.grm. Sp. gr. = 7·57. Analysis gave nothing but—

Fe	99·77
Co	trace
Sn	trace (?)
Quartz	0·25
	100·02

The presence of a trace of cobalt, though in too small quantity to be weighed, was well ascertained. As regards the tin the evidence is merely that a brown colouration was given by sulphuretted hydrogen in the solution of the iron, and the absence of copper was established. If it be admitted that these fragments of iron did not come from the tools used by the gold washers, as seems to be almost certain, it is interesting to find such evidence of wide distribution of native iron as is afforded by this examination of specimens from another state, though derived from the same general geological region.

(86.) *Analysis of Fergusonite from Brindletown, Burke Co., North Carolina.* By W. H. Seamon.

The mineral, sent me by Mr. W. E. Hidden, who first observed it at this locality, was in small crystals and crystal fragments. of distinctly tetragonal habit, reddish brown in colour, with pale yellowish brown steak. Translucent in thin splinters. Lustre between vitreous and resinous. Brittle. Fracture conchoidal. Hardness = 6. Sp. gr. = 5·6. Analysis gave—

Nb_2O_5	43·78	47·86*
Ta_2O_5	4·08	
WO_3	} 0·76	
SnO_2		
UrO_2	5·81	
Y_2O_3, &c.	37·21	
Ce_2O_3	0·66	
Di_2O_3	} 3·49	
La_2O_3		
FeO	1·81	
CaO	0·65	
H_2O	1·62	
	99·87	

As it has been stated by Smith† that this mineral is "totally free from tantalic acid," care was taken in proving the presence of tantalum. A metal or metals of the yttrium group, but of higher atomic weight (erbium, ytterbium, &c.), occurs with the yttrium, but in small proportion only. *Counting the water as basic*, the above figures lead to the ortho-niobate formula of Fergusonite—

$$M'''NbO_4,$$

as nearly as can be expected in view of the uncertainty of several of the atomic weights concerned, especially those of the yttrium metals.

(87.) *Analysis of a Niobate, which has been improperly called Euxenite, from the Wisemann Mica Mine, Mitchell Co., North Carolina.* By W. H. Seamon.

This mineral, of which the specimens examined were also received from Mr. Hidden, although I had previously obtained it from another source, was described some years ago by J. L. Smith‡ as euxenite, though neither in physical characters nor in chemical composition does it agree with the mineral of that name from Norway, of which I have long had specimens.

The material examined by Mr. Seamon was compact, reddish brown in colour, with lustre between resinous and adamantine, and pale yellowish brown streak. Hardness = 5·5. Sp. gr. = 4·33. There was a yellowish crust over the outside of the fragments. The purest por-

* Described by J. W. Mallet in *Amer. Journ. of Science*, July, 1871, and May, 1878.

† Described and analysed last year by Mr. S. Porcher, then a student in this laboratory.—Chemical News, vol. xliv., p. 189.

‡ "Watts's Dictionary of Chemistry," iii., 336.

§ *Amer. Phil. Soc.*: Philadelphia, xi. (1873), 443.

* Weighed together. The sp. gr. of the mixed oxides was very carefully taken, and from this the relative quantities of niobium and tantalum were calculated.

† *Jahrb. für Mineralogie*, 1881, 2. Mem. 337; quoted in *Journ. Chem. Soc.*, Feb., 1882, 151.

‡ *Amer. Jour. of Science*, May, 1877, 365.

tions, free from this crust and from adhering scales of mica, were picked out, and gave on analysis—

Nb_2O_5	47·09
WO_3 .. .. }	0·40
SnO_2 .. .. }	
UrO_2	15·15
Y_2O_3	13·46
Ce_2O_3	1·40
Di_2O_3 .. .. }	4·00
La_2O_3 .. .. }	
FeO	7·09
CaO	1·53
H_2O	9·55
	99·67

The specific gravity of the Nb_2O_5 after ignition proved it to contain no Ta_2O_5, or but a trace. Spectroscopic examination showed that the Y_2O_3 contained but little of any oxide of the Eb or Yb class. Di was present in larger proportion than La, but the two were not separated.

These results indicate an ortho-niobate of the general formula—

$$M''_3Nb_2O_8,$$

in which about one-eighth of the hydrogen of the water is basic, the actual distribution of the basic elements being nearly—

$$(\tfrac{23}{30}M' + \tfrac{3}{30}M'' + \tfrac{3}{30}M''' + \tfrac{1}{30}M'''')Nb_2O_8.$$

Euxenite, beside containing a large proportion (up to 16 per cent) of titanic oxide, which is altogether wanting in this mineral, is a *meta*-niobate, as shown by Rammelsberg.* The large proportion of water, most of which cannot be brought into the formula as basic, and the general appearance of the mineral, with its external crust of yellowish material which penetrates the interior in some places, as well as the rather low specific gravity, makes it probable that we have here a product of alteration of Samarskite (with which it is found) or some allied species.

(To be continued.)

* *Journ. Chem. Soc.* [2], ix., 196.

NOTICES OF BOOKS.

Chemiker-Kalender, 1883. *Beilage zum Chemiker-Kalender*, 1883. By Dr. Rud. Biedermann. Berlin: Julius Springer.

This little work, in two volumes, intended as a pocket reference-book for chemists, physicists, mineralogists, &c., has its English and French representatives in the well-known "Chemist's Pocket-Book" and "Agenda du Chimiste." Like these, it consists of a large number of Tables and data of every description, wholly indispensable to the chemist.

The value of such a work as this to the scientific man depends greatly upon the facility with which any required data can be found when wanted, and the reliance that can be placed on their accuracy, few busy chemists having opportunities to consult the original memoirs, or time at their disposal to search through standard works of reference; consequently it becomes a most important consideration for them that what they possess should be accurate.

The methodical arrangement of the contents of this work before us and the variety of the information leave little to be desired as regards the first requisite: the care with which the present edition has been revised is a sufficient guarantee for its accuracy.

The first volume, which is essentially chemical, gives over sixty pages to a diary, in which, instead of each day being labelled with the name of a Saint, a Feast, or a Fast, we have the birth register of many of the most eminent chemists, dead and living. The calculations required in gas measurements, analyses, and such like, are those of every-day use in the laboratory, logarithms being freely introduced whenever the work can thereby be shortened. The Tables of specific gravities and percentage content of the more common solutions are drawn up under Alkalies, Acids, and Salts, followed by a list of miscellaneous solutions, as Sugar, Alcohol, Albumen, &c. Under Solubilities are given a series of useful Tables, as Gases in Water and in Alcohol, Solids in Water and in Spirits of Wine, Sugar in Water, and Sugar in Alcohol, each of importance in one or other of the large chemical industries.

The remainder of the volume is taken up with long lists of organic and inorganic compounds, their formulæ, melting- and boiling-points, and solubility in various menstrua; Tables for qualitative analysis, spectral analysis, and gas analysis, assaying in the wet and dry way. The last table, valuable to the mineralogist, comprises over 500 minerals arranged alphabetically, with their formulæ, specific gravity, hardness, crystalline form, and colour. To the analyst this Table might be of more use if the minerals were classified in some way, such as the silicates in order of the principal base, ores of copper, iron, &c.

The Supplement to the Kalender contains 89 Tables relating to physical subjects, collected under the headings Mathematics, Weights and Measures, Heat, Tension of Vapours, Light, and Electricity; followed by short descriptions of the various methods for determining the densities of solids, liquids, and gases. In an Appendix are given the principal scientific educational institutions in Germany, the professors, and the subjects taught.

The utility of such a book as the present is beyond question; the fact, however, of it being in two separate parts may not render it quite so handy a vade-mecum as it might otherwise be if it were in one.

Address in Surgery. By W. Stokes, F.R.C.S.I., President of the Pathological Society of Ireland, &c. London: J. and A. Churchill.

The Address before us, delivered at the late Jubilee Meeting of the British Medical Association, bears for its motto the very apposite sentiment "Vérité dans la science, moralité dans l'art." The speaker expounds his aspirations for the future career of the distinguished body whom he was addressing. This Association, as he not unjustly maintains, has been "faithful in its efforts to raise the social status of the profession—faithful in its attempts to extricate public opinion from the quagmires of sentimentalism and folly." Among the tasks remaining to be accomplished, Mr. Stokes urges the importance of a higher general and scientific culture for candidates for the medical profession. The word "general" is here open to more than one interpretation, and it is hence impossible for us to decide how far our sympathies would accompany the learned speaker.

We have next a summary of the chief advances which have been effected in the art of medicine during the last half century. The antiseptic treatment of wounds, especially, is discussed at length. The author, after a careful survey of the results of what is known as "Listerism," gives his verdict in its favour.

Lastly, we have a notice of the "Association for the Advancement of Medicine by Research." The task of this Association, as the author holds, is not easy. It "will have to deal with a section of the public who refuse to be instructed; refuse to recognise established facts; refuse to weigh evidence; substitute groundless assertion for argument, and wilfully and deliberately accuse the scientific physiologist of selfishness and cruelty. In creating so unjust a prejudice there is, I fear, a wilful attempt to pervert the moral sense of the public." He asks, Are efforts for the advancement of physiology "to be thwarted and hindered in the country of Harvey and Jenner?" Truly "a question to be asked."

Tokio Daigaku (University of Tokio). The Calendar of the Departments of Law, Science, and Literature. Published by the University, 2540 (1880).

Turning to the Faculty of Science we find a very numerous staff of professors and assistants, of whom all but seven are native Japanese. There are in chemistry a professor, an assistant professor, two assistants, and a lecturer, besides a professor and an assistant in assaying. In the department of Science there are, it appears, six distinct curricula, viz., chemistry, mathematics with physics and astronomy, biology, engineering, geology, mining and metallurgy. These six courses are all identical for the first year, but for the three subsequent years each student is required to elect one of the courses, and pursue as his special studies those of the course chosen. It is further to be noted that beyond a knowledge of the three great languages of the modern world—English, French, and German—the science student is not compelled to occupy his time with literature. A graduating thesis is in all cases one of the tasks required in the last year of the course. It seems to us, as far as can he judged from the survey before us, that it is the object of the University to initiate the students as early as possible into original scientific work.

CORRESPONDENCE.

ELECTRICITY AND COMETS.

To the Editor of the Chemical News.

Sir,—I am not aware whether the part which electricity may possibly play in some of the phenomena exhibited by comets has been considered by physicists with any special attention; hut may it not he a not unimportant auxiliary agent in some of the phenomena they display; why should not electric currents circulating around the sun, like those which circulate about our earth, act inductively upon the mass of the comet which is so rapidly approaching them, producing currents in an opposite direction to themselves, according to the well-known laws of induction of currents; and seeing that the mass of the comet is not continuous, there would appear incessantly hetween the meteoric fragments, electrical discharges, which would, in passing through the gaseous envelope, develope the high temperature spectra of its component gases; whereas such is, I believe, the nature of the spectra actually ohserved. At the same time these incessant discharges might have something to do with the light emitted by comets.

Another effect might also he not unconnected with these currents. I allude to the apparent solar repulsion of the less dense matter, which, arising in a wave-like motion from the nucleus, has appeared to pass off towards the tail; for it is clear that any currents which might be produced must be such as to cause a repulsion between the sun and the comet.—I am, &c.,

Lester Reed.

Hyrst-hof, South Park Hill Road, Croydon.

A WARNING.

To the Editor of the Chemical News.

Sir,—I am indebted to the "warning" of your correspondent, Mr. A. Proudlock, of October 20, for being enahled successfully to parry an attempt to extract money by a man who is evidently the person referred to in his letter. His last name is Luis, but having taken the precaution to make enquiries of Dr. Campbell Brown, whom he professed to know, I find that he has been carrying on similar operations in Liverpool under the name of Weiss.—I am, &c.,

William A. Tilden.

The Mason Science College, Birmingham, 30th October, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 15, October 9, 1882.

Objections of a Mechanical Order to the Present Theory of Electricity.—A. Ledieu.—The author in seeking for a connection between the theory of electric machines and that of heat engines, has met with inextricable difficulties, resulting from the current principles of electrical science. According to the opinion of most physicists this science presents to the mind not a few confused ideas. These the author expounds mathematically.

Transmission of Work to a Great Distance by Means of an Ordinary Telegraphic Line.—M. Deprez.—In the author's first experiment he ohtained at Munich a work of 38 kilogrammetres per second (= ½ horse-power) with a speed of 1500 revolutions per minute. The generating machine, placed at Miesbach, revolved at the rate of 2200 turns per minute. The two machines being identical the proportion of work recovered at Munich, to that expended at Miesbach, was 60 per cent.

Thermoscopic Method for the Determination of the Ohm.—G. Lippmann.—The author's method differs from that of Mr. Joule merely hy not requiring the measurement of quantities of heat, nor a knowledge of the mechanical equivalent of the heat E. This latter point is not unimportant, since, in Mr. Joule's calorimetric method, the final approximation is limited hy the uncertainty which exists as to the exact value of the number E, so that the possible error is close upon 1·100th.

Rotatory Polarisation of Quartz.—J. L. Soret and E. Sarasin.—Not capable of useful abstraction.

Experiments made to Determine the Compressibility of Nitrogen Gas.—E. H. Amagat.—The author expresses his results graphically. His method and his apparatus are different from those of M. Cailletet.

Certain Compounds of Tin Bisulphide and Biselenide.—A. Ditte.—The author describes the potassium sodium, ammonium, harium, strontium, and calcium sulpho-stannates, potassium and ammonium selenio-sulpho-stannates, and potassium selenio-stannate.

Fermentation of Nitrates.—MM. Gayon and Dupetit.—The authors, referring to the researches of MM. Schlœsing and Müntz, which establish the fact that nitrification in the soil and in organic liquids is due to the development of ærobic microhia, demonstrate that the inverse process, the reduction of the nitrates, is also a physiological phenomenon due to the action of anærobic organisms.

Transformation of Amides into Amines.—M. Baubigny.—It is known that on heating a primary or secondary amine with a compound ether, there is produced an amide, and the alcohol of the compound ether is set at liberty. These amides differ from the corresponding salt of the corresponding amine by four volumes of watery vapour which are eliminated. Inversely these amides can fix 4 vols. of watery vapour, thus regenerating the primitive salt. The same amides are also capable of fixing 4 vols. of the vapour of alcohol, in which case the salt regenerated is the primitive salt in which the amide is replaced hy a substituted amine, a derivative of the alcohol employed.

Decomposition of Tertiary Amyle Acetate by Heat.—N. Menschutkin.—On studying the etherification of the tertiary alcohols and acetic acid, the author has found that it does not proceed regularly; the quantity of ether formed is minimal, and there are produced ethylenic

hydrocarbides. He connects the formation of these compounds to the dissociation of the acetic ethers of the tertiary alcohols at the temperature of the experiment.

No. 16, October 16, 1882.

National Conception of the Nature and the Propagation of Electricity, deduced, first, from the Consideration of the Potential Energy of the Etherial Matter Associated with Ponderable Matter; Second, from the Mode of Production and Transmission of Work, derived from the Variations of this Energy.—A. Ledieu.—A mathematical paper not capable of useful abridgment.

Indices of Ordinary and Extraordinary Refraction of Iceland Spar for Rays of Different Wave-lengths up to the Extreme Ultra-Violet.—E. Sarasin.—The author's results are given in the form of tables.

M. Helmholtz's Theory of Double Electrical Strata. Calculation of the Magnitude of a Molecular Interval.—G. Lippmann.—Not capable of useful abstraction.

Electrolysis of Hydrochloric Acid.—D. Tommasi.—With concentrated acid acted upon by two Daniell elements, the platinum positive electrode is slightly attacked, hydrogen is evolved at the negative pole, and at the positive oxides of chlorine. If the acid is dilute the platinum is not attacked, but the gases given off are the same. The presence of hypochloric acid is probable, but not that of hypochlorous acid, which, if formed, would, in contact with hydrochloric acid, be at once resolved into water and chlorine.

Reduction of Nitrates in Arable Soils.—MM. Dehérain and Maquenne.—Nitrates may exist in an ordinary arable soil if air is excluded without giving off nitrogen. This gas only appears when the proportion of organic matter is augmented. Under certain conditions nitrogen monoxide is also evolved. The reduction of nitrates only occurs when the atmospere of the soil is absolutely free from oxygen.

Chronic Antimonial Poisoning.—MM. Caillol de Poncy and C. Livon.—The results are very similar to those of slow arsenical poisoning. Fatty degeneration of the liver and the lungs was strongly marked.

Journal für Praktische Chemie.
New Series. Vol. xxvi, Nos. 12, 13, and 14.

Researches on Physiological Oxidation.—M. Nencki and N. Sieber.—The authors, continuing their researches on the "Decomposition of Grape-Sugar and Uric Acid by Alkalies at the Temperature of Incubation," proceed to examine what part, if any, is played by atmospheric oxygen in the decomposition of various organic compounds when they are digested in alkaline solutions at the same temperature. The substances examined are chiefly such as are constituents of aliments or of the animal body itself. In following up the results obtained with grape-sugar, they communicate observations on the etiology of *diabetes mellitus*. They conclude that the transformation of the alimentary matters into acids, after which they are converted by the alkaline carbonate of the blood and the tissues into neutral salts, is an essential condition for their combustion in the plasma of the tissues. It seems probable that the cause of *diabetes mellitus* lies in the inability of the organism to convert grape-sugar into lactic acid or other acids, *e.g.*, glykuronic acid. Schultzen reached the same conclusion by another way.

The History of the Basic Products of Putrefaction.—M. Nencki.—The author, referring to a memoir in the *Comptes Rendus* (xciv., 1601) by A. Gautier and A. Etard, states that the second alkaloid described by them, $C_8H_{13}N$, was obtained and analysed by himself six years ago.

On Resocyanine, and the Action of Acetacetic Ether upon the Phenols in the Presence of Dehydrating Agents.—Max Wittenberg.—Does not admit of useful abstraction.

Condensation-products of Phenols and Acetic Acid, and a Simple Method of obtaining the Acid Ethers of the Phenols.—Faustin Rasinski.—The author describes phenaceteine, orcaceteine, and orcacetophenon, phenol-benzoic ether, resorcine-dibenzoic ether, and orcine-benzoic ether.

The Preparation of Grape-sugar according to Neubauer's Direction by means of Schwarz's Method, and its Purity.—Prof. Worm Müller.—The author shows, in opposition to Soxhlet, that pure grape-sugar can be obtained by this method.

The Preparation of Grape-sugar, and its Titration with Knapp's Solution.—J. C. Otto.—A continuation of the last paper. The author compares the grape-sugar obtained by the process in question with a sample of admitted purity, and finds them equally good.

Instructions for the Determination of the Isomerism of Alcohols and Acids by means of Data drawn from their Etherification.—M. Menschutkin.—The new method for determining the isomerism of the alcohols consists in etherifying the alcohol under examination with a molecular quantity of acetic acid at 155°, and determining both the speed and the limit of etherification. The author gives certain necessary precautions, tables for comparison, and the characteristics of the primary alcohols, the primary iso-alcohols, the non-saturated primary, the secondary and tertiary alcohols, and phenols. In order to determine the isomerism of acids they are brought into reaction with a molecular quantity of isobutylic alcohol at 155°, and the observed speed and limit of etherification are compared with those laid down in the appended tables.

Nitrate of Tin.—Rudolph Weber.—The author has observed the formation of an easily inflammable tin nitrate when alkaline nitrates, or moist mixture for gunpowder, come in contact with tin solder. He recommends that such solder should be avoided in powder mills.

An Explanation.—H. Kolbe.—The author points out that A. Klepl's note on an unstable compound of phenol and carbonic acid (vol. xxv., 464) had been, without the knowledge of the author, anticipated by Prof. L. Barth.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 8.

The Injurious Constituents of the Smoke of Copper, Lead, and Zinc Smelting-Works, and their Removal.—Prof. M. Freytag.—The injury occasioned to vegetation in the neighbourhood of smelting-works, or establishments where large quantities of coal rich in sulphur are consumed, was examined thirty-eight years ago by Stöckhard, and referred to the poisoning of the soil by the sulphurous acid emitted and the metallic substances (especially lead oxide) mechanically volatilised. The author having re-examined the question concludes that the injurious action of furnace-fumes is due not to sulphurous acid and metallic oxides, but to sulphuric acid and soluble sulphates. Sulphurous acid is hurtful only when it is absorbed by moist leaves, and is rapidly oxidised to sulphuric acid. A direct poisoning or deterioration of the soil by acid vapours and accompanying metallic compounds does not occur. The latter, however, may become dangerous when they are deposited on the leaves of plants, and thus introduced into the bodies of cattle. Moist winds (the west wind) increase the zone of injury around smelting-works, which, in consequence, has its greatest extension eastwards. The gases are most injurious when they pass over plants moist with the evening and morning dews. Such gases have a peculiar disposition to follow a river without regard to its direction. To prevent a mistaken diagnosis the author points out that a number of

animal and vegetable parasites, as well as frost, drought, and a bad conditiion of the soil, may occasion phenomena very similar to smoke-damage. Flue-dust is arrested by passing the fumes through condensation-fumes. It contains more than 50 per cent of anhydrous sulphates and 7½ per cent of arsenious acid. The acid fumes are due not merely to the sulphur of the ores which escapes oxidation in the lead chambers, but to the sulphur present in coal. The author proposes to pass the gases, first freed from flue-dust, through a lead chamber in which they encounter a shower of "atomised" sulphuric acid.

Quantity and Composition of the Rain and Drainage Water at Rothamsted.—Messrs. Lawes, Gilbert, and Warington.—From the *Journ. Roy. Agr. Soc. of England.*

Manurial Experiments on Sugar Beets in Süderdithmarschen.—Vitter Thiessen.—Comparative experments with soda, saltpetre, and Mejillones guano. The former of these manures greatly increased the crop without perceptibly injuring the quality.

Manurial Experiments with Soluble and Finely-ground Phosphates at Crawley-Mill Farm, Woburn.—Dr. A. Voelcker.—From the *Journ. Roy. Agr. Soc.*

The Analytical Determination of Reverted Phosphates.—MM. Fresenius, Joulie, Millot, Petermann, &c.—The compiler describes the ammonium citrate method as devised by Fresenius, and modified by Joulie, Petermann, &c., and points out the disturbing effects of gypsum, calcium chloride, chalk, and ammonium carbonate.

Examination of Sheeps' Milk under Different Conditions of Nutrition.—Prof. Weiske and Dr. Keunepohl.—The milk of the sheep is distinguished from that of the cow by a higher percentage of solids, albumenoids, and fat.

Theoretical Considerations on the Problem of Assimilation.—J. Reinke.—Not suitable for useful abstraction.

Occurrence of Allantoine and Asparagine in the Young Leaves of Trees.—E. Schulze and J. Barbieri.—From the *Journ. für Prakt. Chemie.*

The Reducing Properties of Living Cells.—J. Reinke.—From the *Ber. der Deutsch. Chem. Gesells.*, as is also the following paper:—

Reducing Properties of Living Protoplasm.—O. Loew and T. Bokorny.

A Contribution to the Knowledge of the Easily Oxidisable Compounds of the Vegetable Body.—J. Reinke.—The author's researches show that readily oxidisable principles occur in plants of very different families, belonging apparently to the atomatic series. It may be suspected that they are connected with the respiratory functions.

Need for Water among different kinds of Grain.—Dr. Paul Sorauer.—Not adapted for useful abstraction.

New Method of Testing the Germinating Power of Seeds.—L. Digeon.—The author takes a given number of seeds, lays them one by one carefully upon burning charcoal kept at a glow, and observes how they burn. Good seeds spring up, turn over, and burn with a crackling noise, which is stronger the larger the seeds, whilst seeds of inferior germinating power smoulder slowly, with a faint emission of smoke.

Constituents of the most important Articles of Diet for Invalids and Children, and of certain Proprietary Foods.—Dr. Stutzer.—In some foods for children the digestible albumenoids are to the carbo-hydrates only as 1 : 40, 1 : 12, 1 : 20, &c., whilst in human milk the proportion is 1 : 5. The worthlessness of the foods in question is at once evident.

Proportion of Sulphuric Acid in Red Wines, and on De-acidifying Wines with Potassa or Lime.—Prof. J. Nessler.—The author has determined the amount of sulphuric acid in a series of wines of different vintages and grown on different soils. A normal wine, neither contaminated with gypsum nor sulphured, never contains more than 1·3 grms. potassium sulphate per litre.

On Phylloxera Vastatrix.—A compilation of suggested remedies for this plague.

Moniteur Scientifique, Quesneville.
August, 1882.

Study on the Formation and Constitution of β-Naphtho-quinone and on some of its Derivatives.—C. Liebermann and P. Jacobson.—The results of the authors' investigations are that β-naphtho-quinone is an isomer of α-naphtho-quinone, the two atoms of oxygen being contained in the same nucleus and occupying adjacent positions. On introducing the group NO_2 into aceto-β-naphthalide, or the groups NO and N_2 into β-naphthol, we substitute the same atom of hydrogen which occupies the ortho-position; in the case of α-naphthol the action of the group N_2 occurs in the para-position. The anilides and toluides of β-naphtho-quinone have an acid character; the isomeric derivatives of α-naphtho-quinone still contain the original quinonic group and are insoluble in alkalies. The transformation of the anilide of β-naphtho-quinone into isomeric α-derivatives is the result of two very distinct reactions.

α- and β-Amylane in Cereals.—C. O'Sullivan.—From the *Journ. of the Chem. Soc.*

Tolerance of "Plastered" Wines.—M. Mencki.—From the *Journ. für Praktishe Chemie.*

The Ptomaines and their Importance in Toxicological Chemistry and in Judicial Researches.—M. Huseman.—From the *American Journal of Pharmacy.*

MEETINGS FOR THE WEEK.

MONDAY, 6th.—Royal Institution, 5. General Monthly Meeting.
Society of Chemical Industry, 8. "The Flashing Test for Petroleum," Prof. Abel. "New Process for the Manufacture of Sodium Sulphide and Potassium Sulphide," W. Weldon, F.R.S.
SATURDAY, 11th.—Physical, 3. "Three Historical Notes on Physics," Prof. S. P. Thompson, "Conservation of Energy and the Theory of Central Forces," W. R. Browne.

TO CORRESPONDENTS.

Thomas Weir.—Richardson and Watts's "Technology," published by Baillière.

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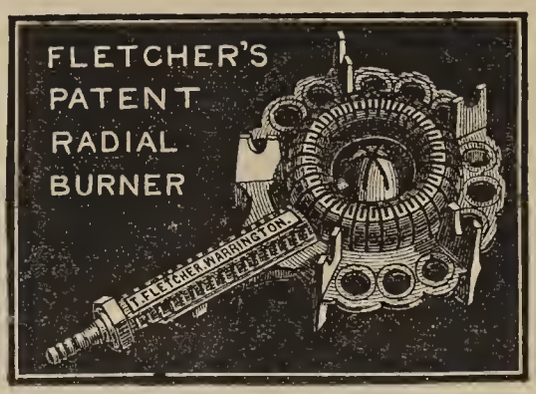

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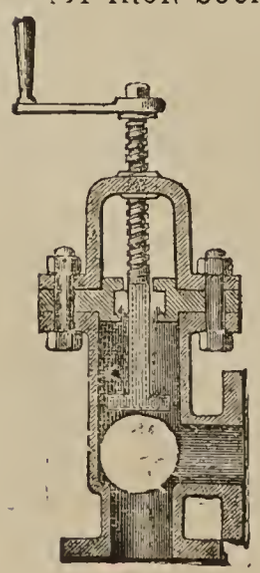

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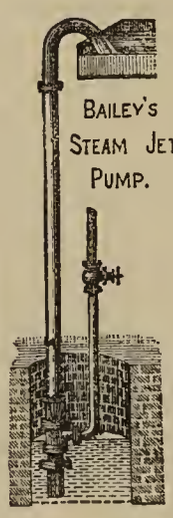

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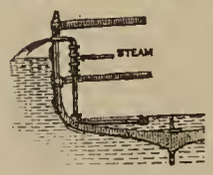

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THE CHEMICAL NEWS.

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SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Tin (*Stannic Salts*).—1. The best process is to treat a decidedly acid hydrochloric solution with a prolonged current of hydrosulphuric acid. The tin sulphide does not retain gallium. The operation succeeds equally well with the stannic, the metastannic, or the stannous chloride. In the last case brown stannous sulphide is formed.

2. The solution in sodium or ammonium sulphide is treated with an excess of hydrochloric acid. The tin sulphide retains little or no gallium; it may be re-dissolved in ammonium hydrosulphate and re-precipitated with hydrochloric acid.

With the stannous salts we use an alkaline sulphide saturated with sulphur, which converts the stannous sulphide into the corresponding stannic compound.

3. The salts of manganese, if added to the solution of the gallio-stannic compound in an alkaline sulphide form manganese sulphide, which carries down gallium. Unfortunately there is great difficulty in collecting the manganese sulphide completely, and in washing it well. In general a certain quantity of stannic sulphide remains upon the filter after the manganese sulphide has been treated with hydrochloric acid. This stannic sulphide should be re-dissolved in ammonium hydrosulphate and the solution treated either with a salt of manganese or dilute hydrochloric acid. Notwithstanding these inconveniences the present process is sometimes applicable to the extraction of traces of gallium contained in large masses of sulpho-alkaline tin compounds.

It may be useful to give certain cautions to chemists about to analyse galliferous compounds.

A.—Stannic chloride is not immediately precipitated by potassium ferrocyanide in a very acid hydrochloric solution. By degrees a slight opalescence appears, and if the solution is not very dilute the whole finally forms a solid jelly without the separation of any precipitate. It is a singular thing that if the liquid contains gallium chloride even in a very sensible proportion, there is formed no precipitate of gallium ferrocyanide during the long period for which the mixture remains limpid, whilst a check-sample containing an equal weight of gallium chloride, but without stannic chloride, gives a copious precipitate. If heated, very acid stannic chloride becomes turbid as soon as potassium ferrocyanide is added. Hence it is necessary to remove tin before determining gallium by means of ferrocyanide.

B.—Tin and gallium cannot be separated by treating their alloy with nitric acid. Metastannic acid retains notable quantities of gallium even after prolonged washings.

C.—It is difficult to separate gallium and tin by reducing the latter metal with zinc. In a very acid solution the tin is not entirely deposited, and if the liquid is nearly neutral a quantity of gallium is rendered insoluble

D.—Stannic oxide precipitated at a boil with sulphuric acid carries down much gallium.

Separation from Antimony (*Antimonious Salts*). 1. The most simple method is to treat the hydrochloric solution with sulphuretted hydrogen. If the acidity is suitable no antimony remains in solution, and we obtain Sb_2S_3 free from gallium. The separation is effected even if the acid solution has been rendered previously turbid by dilution. If the liquid is too acid, and if a little antimony has thus escaped the action of the sulphuretted hydrogen, we add a few drops of ammonia (but without neutralising the solution), and thus collect a small supplementary precipitate of sulphide. Sulphuretted hydrogen also separates gallium from antimonic salts, *e.g.*, the hydrochloric solution of potassium bimeta-antimoniate and potassium bi-antimoniate suspended in water acidified with hydrochloric acid.

2. The solution in ammonium hydrosulphate is treated with an excess of dilute hydrochloric acid. If it is feared that traces of gallium have been left in the antimony sulphide it is re-dissolved in an alkaline sulphide and re-precipitated with hydrochloric acid.

This process applies to the antimonic as well as to the antimonious salts.

3. Potassium ferrocyanide precipitates gallium from a very acid hydrochloric liquid containing antimonious chloride. Distinct traces of antimony are found in the deposit. It is therefore re-dissolved in potassa and re-precipitated by means of hydrochloric acid to which a few drops of ferrocyanide have been added.

4. A salt of manganese, added to a solution in ammonium hydrosulphate, removes slight traces of gallium mixed with much antimony. This process, useful in certain special cases, presents the drawbacks pointed out above, when speaking of the separation of tin and gallium by means of manganese sulphide. It is equally applicable to antimony in all states.

Zinc reduces the salts of antimony much more completely than those of tin, but this reaction is not well applicable in analysis because, according to the degree of acidity, either antimony escapes reduction or a little gallium is carried down. There is also loss in consequence of the formation of antimony hydride.—*Comptes Rendus*, No. 17, xcv.

NEW METHOD OF DETECTING DYES ON YARNS AND TISSUES.

By JULES JOFFRE.

The reagents employed are—a solution of caustic potassa in 10 parts of water; hydrochloric acid diluted with an equal bulk of water, or occasionally concentrated; nitric acid, ammonia, ferric sulphate, and a concentrated solution of tin crystals. The most convenient method of operating is to steep small portions of the cloth under examination in a little of the reagent placed at the bottom of a porcelain capsule. The bits are then laid on the edge of the capsule, when the changes of colour which they have undergone may be conveniently observed. It is useful to submit to the same reagents simultaneously portions of cloth dyed in a known manner with the wares which are suspected of having been used in dyeing the goods under examination.

Red Colours.

By the action of caustic potassa the reds are divided into four groups: 1, those which turn to a violet or blue; 2, those which turn brown; 3, those which are changed to a light yellow or grey; 4, those which undergo little or no change.

The first group comprises madder, cochineal, orchil, alkanet, and murexide. Madder reds are turned to an orange by hydrochloric acid, whilst the three next are not notably affected Cochineal is turned by the potassa to a violet-red, orchil to a violet-blue, and alkanet to a decided blue. Lac-dye presents the same reactions as cochineal, but has less brightness. Ammoniacal cochineal and carmine may likewise be distinguished by the tone of the reds obtained.

A characteristic of madder reds is that, after having been turned yellow by hydrochloric acid, they are rendered violet on treatment with milk of lime. A boiling soap-

lye restores the original red, though somewhat paler. Artificial alizarine gives the same reaction. Turkey-reds, however, are quite unaffected by acid. Garancine and garanceux reds, if treated first with hydrochloric acid and then with milk of lime, turn to a dull blue.

Madder dyes are sometimes slow in being turned to a violet by potassa, and this shade when produced is often brownish. They might thus be confounded with the dyes of the fourth group, *i.e.*, rosolic acid, coralline, eosine, and coccine. None of these colours gives the characteristic reaction with milk of lime and boaling soap-lye. If plunged in milk of lime they resume their rose or orange shades, whilst the madder colours become violet. Murexide is turned, by potassa, grey in its light shades and violet in its dark ones. It might, then, be confounded with orchil, but it is decolourised by hydrochloric acid, which leaves orchil a red. Moreover it is turned greenish by stannous chloride.

A special character of this dye (murexide) is the presence of mercury, the salts of which serve as mordants for fixing it, and may be detected by the ordinary reagents.

The second group comprises merely santal-wood or sanders red, which turns to a brown. On boiling it with copperas it becomes violet, whilst on boiling with potassium dichromate it changes to a yellowish brown.

The third group includes safflower, magenta, and murexide (light shades). If the action of the potassa is prolonged the (soft) red woods enter into this group. Safflower turns yellow by the action of potassa, and the original rose shade is not restored by washing with water. Hydrochloric acid turns it immediately yellow. Citric acid has no action. Magenta is completely decolourised by potassa, but a prolonged washing in water reproduces the original shade. This reaction is common to many aniline colours. These decolourations and recolourations are easily produced in dark shades, whilst in very light shades they are less easily observed because there is always a certain loss of colour. Stannous chloride turns magenta-reds to a violet. Hydrochloric acid renders them yellowish brown (afterwards greenish ?). Water restores the purple-red shade.

The fourth group comprises saffranine, azo-dinaphthyl diamine, rosolic acid, coralline, pure eosine, and eosine modified by a salt of lead, coccine, artificial ponceau, and red-wood.

Saffranine is detected by the action of hydrochloric acid, which turns it to a beautiful blue; the red colour is restored by washing in water. Azo-dinaphthyl diamine is recognised by its peculiar orange cast, and is turned by hydrochloric acid to a dull dirty violet. Rosalic acid and coralline, as well as eosine, are turned by hydrochloric acid to an orange-yellow: the two former are distinguished from eosine by their shade, which inclines to a yellow. Potassa turns rosolic acid and coralline from an orange-red to a bright red, whilst it produces no change in eosine. If the action of potassa is prolonged, modified eosine is blackened in consequence of the decomposition of the wool, the sulphur of which forms lead sulphide. Coccine becomes of a light lemon-yellow on treatment with hydrochloric acid. Washing with water restores the original shade. It affords the same reactions as eosine, but its tone is more inclined to an orange.

Artificial ponceau does not undergo any change on treatment with hydrochloric acid, and resists potash. Red-wood shades are turned towards a gooseberry-red by hydrochloric acid, especially if strong. This last reaction not being very distinct, red-wood shades might be mistaken for those of artificial ponceau but for the superior brightness of the latter. If the action of potassa is prolonged the red-wood shades are decolourised, and a washing with water then bleaches the tissue. Rocelline affords the same reactions as artificial ponceau, but if steeped in a concentrated solution of stannous chloride it is in time completely discharged, which is not the case with artificial ponceau.

Violet Colours.

Violets are divided into two groups: those affected by potassa, and those upon which it has no action. The first group embraces logwood, orchil, alkanet, and aniline violets, including under the latter term Perkin's violet (probably the original "mauve"), dahlia, Parme or magenta violet, methyl and Hofmann's violets. The action of potassa gives indications for each of these violets. Logwood violet is browned; that of orchil, if slightly reddish, is turned to a blue-violet; that of alkanet is modified to a fine blue. Lastly, Perkin's mauve, dahlia, and methyl violet become of a greyish brown, which may be re-converted into a fine violet by washing in abundance of water. When the shades are very heavy this greyish brown is almost of a violet-brown, so that the violets might seem to be unaltered.

The action of hydrochloric acid distinguishes these colours better still if the aid of ammonia is called in for two cases. The acid turns logwood violet to a fine red, and equally reddens orchil violet. But the two colours cannot be confounded, firstly, because the two violet shades are very distinct, that of orchil being much the brighter; and secondly, because ammonia has no action on logwood violet, whilst it turns orchil violet, if at all reddish, to a blue shade. Hydrochloric acid, whether dilute or concentrated, is without action on alkanet violet. If the acid is dilute it is equally without action on Perkin's violet and dahlia. If it is strong it turns them blue, and even green if in excess. Hofmann's violet turns green even with dilute acid, but prolonged washing restores the original violet shade. Dahlia gives a more blue shade than Perkin's mauve. The action of acid is equally characteristic for methyl violet. It becomes green, then yellow. Washing in water re-converts it first to a green, and then to a violet.

The second group includes madder violet, cochineal violet, and the compound violet of cochineal and extract of indigo. These three dyes are thus distinguished:—Hydrochloric acid turns the madder violet-orange, slightly brownish, or a light brown, and it affords the characteristic reaction of the madder colours described above under Reds. Cochineal violets are reddened. Sometimes they are decolourised, and become finally yellow, but do not pass through a brown stage.

The compound violet of cochineal and extract of indigo presents this characteristic reaction, that if boiled with very weak solution of sodium carbonate the liquid becomes blue, rather greenish, whilst the cloth becomes a vinous-red.—*Moniteur Scientifique.*

(To be continued.)

DETERMINATION OF POTASSA IN MANURES.

By M. E. DREYFUS.

The method generally adopted for the determination of potassa in manures, *i.e.*, the direct incineration of the sample, may in certain cases occasion considerable errors in consequence of the volatilisation of a portion of the potassium products.

To avoid this inconvenience the author proposes a preliminary treatment of the manure with sulphuric acid at 1·845 sp. gr., to convert potassium nitrate and chloride into the fixed sulphate. The sulphuric acid attacks the manure energetically, and much facilitates the incineration, which may be effected at a dark red heat. The ignited portion (10 grms.) is exhausted with boiling distilled water acidulated with hydrochloric acid, and the filtrate, when cold, is made up to 500 c.c. Of this solution 50 c.c, representing 1 grm. of the sample, are taken, and, after being heated until close upon ebullition, baryta-water is added until a strong alkaline reaction is obtained. The sulphuric and phosphoric acids, alumina, magnesia, &c.,

are thus precipitated. The filtrate is heated to a boil, and mixed with ammonia and ammonium carbonate, to precipitate the excess of baryta in solution. The last traces of lime are eliminated by means of a few drops of ammonium oxalate. The filtrate is evaporated down on the water-bath, and the ammoniacal salts are expelled by carefully raising the temperature to dull redness. After having taken up the residue in distilled water it is treated with platinum chloride, and the potassium chloro-platinate obtained is reduced with oxalic acid. The quantity of potassa present in the manure can be calculated from the weight of platinum obtained.—*Bull. de la Soc. Chim. de Paris.*

ON THE ESTIMATION OF PHOSPHORIC ACID AS MAGNESIC PYROPHOSPHATE.*

By THOMAS S. GLADDING, A.M.

In a valuable pader on the determination of phosphoric acid as magnesic pyrophosphate (*Amer. Chem. Jour.*, vol. 1, 391) Gooch has demonstrated that this method, far from being as accurate as is generally supposed, is peculiarly liable to sources of error, which cause a considerable over-estimation of the phosphoric acid actually present.

The great importance of this analytical determination from a commercial point of view gives enhanced interest to any enquiry as to its accurate execution. In view of the vast capital at present engaged in the conversion of phosphatic materials into artificial fertilisers, and in view of the fact that chemists frequently differ so widely in this important determination, the necessity, both for the interests of commerce and the credit of science, of an accurate and rigid method can be clearly understood. In the case of large and valuable cargoes sold upon chemical analysis, the slight error of even $\frac{1}{10}$ of a per cent in the estimation of phosphoric acid causes a difference in value ranging from twenty-five up to 200 dollars.

I have been led by these considerations to a careful examination of the modes of procedure at present recommended by the best authorities and which are in common use among chemists.

In the latest American edition of "Fresenius's Quant. Analysis" the directions are, to add to the neutral or moderately ammoniacal solution of the phosphate, magnesia mixture in slight excess, and after letting stand for some time, $\frac{1}{3}$ its volume of strong ammonia solution. In the case of a previous precipitation as phospho-molybdate of ammonia, this precipitate is dissolved in weak ammonia and the neutral or slightly ammoniacal solution treated as above.

The method recommended by the convention of chemists of the different experimental stations of Germany (held in Dec., 1881) is translated as follows:—(*Zeit. für. Anal. Chem*, 21, p. 290). "The beaker glass is now placed under the funnel, the filter pierced with a platinum wire, the precipitate washed into the beaker glass with 2½ per cent ammmonia liquor, and dissolved by stirring with a glass rod, and then enough of the 2½ per cent ammonia liquor added to bring the volume of the liquid up to about 75 c.c. To 0·1 grm. phosphoric acid, 10 c.c. magnesia mixture are now dropped in, accompanied by a constant stirring up." In a foot-note is added "a gradual addition of the magnesia mixture is advisable under all circumstances, even when the ammoniacal solution of the molybdate precipitate is previously nearly neutralised by addition of hydrochloric acid." This mode of procedure differs from that given in "Fresenius" principally in the one point of *insisting on a gradual* addition of the magnesia mixture. In both methods a strongly ammoniacal magnesia mixture is employed, and this is added to a more or less strongly ammoniacal solution of the phosphate.

On the other hand, the method giving the best results in the hands of Gooch consisted in the addition of a *neutral* magnesia mixture to a *neutral* solution of the phosphate, or still better, especially in the case of a previous precipitation as molybdic salt, in a double precipitation of the ammonia-magnesia-phosphate.

In testing the above methods great care was exercised in the preparation of the standard solutions. These were made by the use of chemically pure microcosmic salt. Upon careful ignition of this salt in a covered platinum capsule 5·1415 grms. gave 2·5110 grms. of phosphate of soda as residue, or 34·00 per cent of phosphoric acid against 33·98 per cent required by theory. With this salt, two solutions were prepared, the one containing 4·121 grms. of the salt in a litre or 0·035 grm. P_2O_5 in every 25 c.c., the other 20·605 grms. to a litre or 0·175 grm. of P_2O_5 in every 25 c.c. 25 c.c. were measured off with great accuracy by means of a pipette holding exactly 25 c.c. by careful weight test, when filled to the mark. This was then carefully rinsed out. The small neck of the pipette makes it easy to measure a liquid to within $\frac{1}{100}$ c.c. by this method. In addition to the experiments made with these solutions, others were made by direct weighings of the microcosmic salt.

Method I.

To the solution of the phosphate, diluted to 50 c.c. and made slightly *alkaline* by the addition of ½ c.c. of ammonia liquor, the regular ammoniacal magnesium chloride mixture was added, 4 c.c. to every 25 c.c. of solution I., and 18 c.c. to every 25 c.c. of solution II. After letting stand for 15 minutes, 25 c.c. of strong ammonia solution were added, and the liquid filtered off after about 30 minutes. The washing was performed with strong ammonia solution, and was continued until 10 drops of the washings gave no precipitate with silver nitrate when acidified. In these and all subsequent experiments the filter-papers were each weighed, that an accurate weight allowance might be made for filter ash, and the precipitate was strongly ignited over a blast lamp for several minutes, until white. Two series of experiments were made, the one without a previous precipitation as phospho-molybdate of ammonia, the other with such previous precipitation.

A.—Without previous precipitation as molybdate salt.

	Amount taken.	$Mg_2P_2O_7$ found.	P_2O_5 required.	P_2O_5 found.	Error.
1.	25 c.c. sol. I.	0·0559	0·0350	0·03575	2·14 p.c.
2.	,,	0·0557	,,	0·03563	1·80 ,,
3.	,,	0·0559	,,	0·03575	2·14 ,,
4.	,,	0·0557	,,	0·03563	1·80 ,,
5.	25 c.c. sol. II.	0·2770	0·1750	0·17718	1·25 ,,
6.	,,	0·2763	,,	0·17673	0·99 ,,
7.	,,	0·2760	,,	0·17654	0·88 ,,
8.	,,	0·2762	,,	0·17666	1·95 ,,

Average error 1·50 per cent.

B.—With previous precipitation as molybdate salt.

	Amount taken.	Mg_2P_2O found.	P_2O_5 required.	P_2O_5 found.	Error
1.	25 c.c. sol. I.	0·0559	0·0350	0·03575	2·14 p.c.
2.	,,	0·0559	,,	0·03575	2·14 ,,
3.	,,	0·0558	,,	0·03569	1·97 ,,
4.	,,	0·0556	,,	0·03555	1·57 ,,
5.	25 c.c. sol. II.	0·2768	0·1750	0·17705	1·17 ,,
6.	,,	0·2780	,,	0·17782	1·61 ,,
7.	,,	0·2774	,,	0·17744	1·40 ,,
8.	,,	0·2776	,,	0·17756	1·46 ,,

Average error 1·68 per cent.

Method II.

The same course was followed as in method I., excepting that the solution of phosphate was exactly NEUTRALISE D before the addition of the magnesia mixture.

* From the *Journal of the American Chemical Society*. Communicated by the Author.

A.—Without previous precipitation as molybdate salt.

	Amount taken.	$Mg_2P_2O_7$ found.	P_2O_5 required.	P_2O_5 found.	Error.
1.	25 c.c. sol. I.	0·05570	0·0350	0·03563	1·80 p.c.
2.	,,	0·05570	0·0350	0·03563	1·80 ,,
3.	25 c.c. sol. II.	0·2758	0·1750	0·17641	0·81 ,,
4.	,,	0·2757	0·1750	0·17635	0·77 ,,
5.	,,	0·2753	0·1750	0·17609	0·62 ,,

Average error 1·16 per cent.

B.—With previous precipitation as molybdate salt.

	Amount taken.	$Mg_2P_2O_7$ found.	P_2O_5 required.	P_2O_5 found.	Error.
1.	25 c.c. sol. I.	0·0556	0·0350	0·03555	1·57 p.c.
2.	,,	0·0556	0·0350	0·03555	1·57 ,,
3.	25 c.c. sol. II.	0·2770	0·1750	0·17718	1·25 ,,
4.	,,	0·2772	0·1750	0·17731	1·32 ,,

Average error 1·43 per cent.

Method III.

To the solution of phosphate, 75 c.c. in volume and quite strongly ammoniacal, the magnesia mixture was added at the rate of one drop a second, the contents of the beaker being kept in constant rotation. The magnesia mixture was added from a burette, the rapidity of flow being regulated by a glass cock, or still better from an ordinary Mohr burette, the flow being regulated by a screw-clamp. The beaker was slightly inclined, so as to receive the drops on its side. The magnesia mixture by this arrangement flowed down the side of the beaker in a thin stream and an exceedingly gradual admixture with the phosphate solution was thereby secured. After the addition of the magnesia mixture, 25 c.c. of strong ammonia were added and the whole allowed to stand for two or three hours. Very strong ammonia water was used in the washing, as in several cases a tendency to run through the filter-paper was observed, when a weaker ammonia solution happened to be employed. One part concentrated ammonia water to three parts water was employed.

A.—Without previous precipitation as molybdate salt.

	Amount taken.	$Mg_2P_2O_7$ found.	P_2O_5 required.	P_2O_5 found.	Error.
1.	25 c.c. sol. I.	0·0547	0·0350	0·03499	0·00 p.c.
2.	,,	0·0547	0·0350	0·03499	0·00 ,,
3.	25 c.c. sol. II.	0·2736	0·1750	0·17500	0·00 ,,
4.	,,	0·2735	0·1750	0·17494	0·03 ,,
5.	,,	0·2738	0·1750	0·17513	0·07 ,,
6.	0·5231 g. micro. salt	0·2775	0·17775	0·17750—0·14	,,
7.	0·5120	0·2717	0·17397	0·17379—0·10	,,

Average error 0·0 per cent.

B.—With previous precipitation as molybdate salt.

	Amount taken.	$Mg_2P_2O_7$ found.	P_2O_5 required.	P_2O_5 found.	Error.
1.	25 c.c. sol. I.	0·0548	0·0350	0·03505	0·14 p.c.
2.	,,	0·0548	0·0350	0·03505	0·14 ,,
3.	25 c.c. sol. II.	0·2736	0·1750	0·17500	0·00 ,,
4.	,,	0·2734	0·1750	0·17488—0·07	,,
5.	,,	0·2732	0·1750	0·17475—0·14	,,
6.	,,	0·2733	0·1750	0·17481—0·11	,,

Average error 0·10 per cent.

Method IV.

To the solution containing the phosphate, either neutral or ammoniacal, the magnesia mixture was added, and then 25 c.c. of concentrated ammonia water. After letting stand for thirty minutes, the liquid was filtered off and the precipitate thoroughly washed on the paper. The precipitate was then dissolved on the paper with dilute HCl and washed into the original beaker. 25 c.c. of concentrated ammonia solution were now added to the filtrate, no care being taken to add it gradually. After the flocculent precipitate had settled, 5 c.c. magnesia mixture were added, and the whole allowed to stand for several hours. The second precipitation was found to be incomplete without the addition of this extra magnesia mixture.

A.—Without previous precipitation as molybdate salt.

	Amount taken.	$Mg_2P_2O_7$ found.	P_2O_5 required.	P_2O_5 found.	Error.
1.	25 c.c. sol. II.	0·2736	0·1750	0·1750	0·00 p.c.
2.	,,	0·2735	0·1750	0·17494	0·03 ,,
3.	,,	0·2736	0·1750	0·17500	0·00 ,,
4.	0·5095 g. micro. salt	0·2712	0·17313	0·17336	0·13 ,,
5.	0·5703 ,,	0·3030	0·19379	0·19380	0·00 ,,
6.	1·0108 ,,	0·5372	0·34347	0·34361	0·04 ,,

Average error 0·03 per cent.

B.—With previous precipitation as molybdate salt.

	Amount taken.	$Mg_2P_2O_7$ found.	P_2O_5 required.	P_2O_5 found.	Error.
1.	25 c.c. sol. II.	0·2738	0·1750	0·17512	0·07 p.c.
2.	,,	0·2736	0·1750	0·1750	0·00 ,,

Average error 0·035 per cent.

Still another method was investigated as follows:—To the *neutral* solution of phosphate was added a *neutral* magnesia mixture in slight excess. No precipitate appeared except in the case of very concentrated solutions. An extremely weak ammonia water was then added, drop by drop, to the liquid, to which was imparted at the same time a constant rotary motion. An exceedingly granular, pure precipitate was thus produced. The results obtained were perfectly accurate, but as the precipitate was very light and apt to fly, when removed from the paper into the capsule, for ignition, and as the method involved the extra labour over Method III. of first neutralising the solution, it was not carried out in full.

A series of determinations by these several methods, on different fertilisers received in the course of business, was also carried out. The average error is calculated from the results obtained by Method IV., regarded as correct.

Fertiliser.	Method I. P_2O_5 p.c.	Method II. P_2O_5 p.c.	Method III. P_2O_5 p.c.	Method IV. P_2O_5 p.c.
Superphosphate	10·88			10·50
,, ...		9·49	9·38	9·37
Acid phosphate	14·65			14·20
,, ...	15·20			14·75
Tankage	16·96			16·06
,, ...		16·86		16·44
Bone-meal	22·20			21·60
,, ...		21·83		21·51
Rock phosphate	25·15	24·96		24·45
,, ...		28·93	28·32	28·39
Bone-ash	30·25		29·76	29·80
Bone-black			34·39	34·33
	Average error. 0·56 per cent.	Average error. 0·36 per cent.	Average error. 0·04 per cent.	

A study of these results demonstrates that the common method of precipitation as carried out under Methods I. and II. will invariably give results too high. In fertiliser work the error thus introduced will vary all the way from one or two tenths of a per cent when the solution is carefully neutralised and when it chances to be very dilute, up to six tenths per cent or even higher when the solution is more concentrated, or when molybdate of ammonia is present, or where the solution is strongly or even moderately ammoniacal when the magnesia mixture is added. This great variation of error undoubtedly explains many of the differences that have occurred in the analyses of different chemists. The errors thus obtained clearly arise from the too sudden formation of the ammonia-magnesia phosphate precipitate, the precipitate carrying down with it extraneous matter, the error increasing, of course, when a large amount of molybdate of ammonia is present.

When no foreign matter is present and the exact theoretical amount of magnesium chloride is contained in the solution, this sudden precipitation is not injurious, as is seen in Method IV. Method III. when carried out as here described gives accurate results even in the presence of molybdate of ammonia. This method, as it does not necessitate any previous neutralisation of the solution with hydrochloric acid, and requires but one precipitation, is the one to be most highly recommended. Strong ammonia water should be added in liberal amount to the solution, and also employed in the washing.

The breaking of the filter-paper and washing of the molybdate salt in the beaker, without filtering the solution, cannot be recommended. However thoroughly the yellow salt may be washed, there is always a slight residue insoluble in ammonia water. A solution and filtration of the molybdic precipitate is therefore necessary in accurate work.

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. XI.

Communicated by J. W. MALLET,
Professor of General and Applied Chemistry in the University.

(Concluded from p. 206.)

(88.) *Analysis of a Mineral allied to Orthite, from the same locality as the last.* By W. H. SEAMON.

This mineral, also sent me by Mr. Hidden, occurs in fairly well defined flattened crystals, agrecing in form with orthite (allanite), imbedded in the soft kaolin of the Wiseman mica mine. The colour is pitch-black, with sub-metallic lustre. Streak brownish grey. Imperfect conchoidal fracture. Hardness = 6. Sp. gr. = 3·15. Analysis gave—

SiO_2	39·03
Al_2O_3	14·33
Y_2O_3	8·20
Ce_2O_3	1·53
Fe_2O_3	7·10
FeO	5·22
MgO	4·29
CaO	17·47
H_2O	2·78
	99·95

The absorption-spectrum of the Y_2O_3 in concentrated solution gave no distinct evidence of the presence of Eb, Yb, &c., and Di and La were present in but minute amount.

These results correspond to an ortho-silicate in which the hydrogen of the water is probably to be taken as basic, and in which the distribution of basic elements is pretty closely—

$$(\tfrac{6}{12}M' + \tfrac{3}{12}M'' + \tfrac{3}{12}M''')SiO_4.$$

The mineral exhibits, however, as to its individual constituents, a very unusual variety of this extremely variable species. The amount of cerium, &c , is extraordinarily low, contrasting strikingly with the proportion found in the mineral from Bedford Co., Va., the analysis of which is given above (79). The yttrium group is, on the contrary, represented in notable quantity, while the amounts of calcium and magnesium found are much larger than usual.

(89.) *Examination of a New Sulphide received as Fahlerz, from the "Great Eastern Mine," Park Co., Colorado.* By W. T. PAGE.

The general appearance of the specimen in question was that of Fahlerz. It seemed to be quite homogeneous, except that it was somewhat interpenetrated by gangue. The colour was steel-grey, with metallic lustre and dark red streak. Crystalline structure, but no faces that could be identified. Brittle, with uneven fracture. Hardness = about 4. Sp. gr. = 4·89. Fusible before the blowpipe flame, with production of antimonial fumes. A careful analysis gave—

S	26·88
Sb	34·47
Cu	23 20
Zn	7·14
Fe	1·38
Pb	1·19
Siliceous residue	5·86
	100·12

These numbers correspond, not with the tetrahedrite formula—

$$4\{(Cu'_2+M'')S\}.Sb_2S_3.$$

but with that of Bournonite and Stylotypite,—

$$3\{(Cu'_2+M'')S\}.Sb_2S_3.$$

The mineral now reported on is, however, peculiar in containing copper, *one half as cuprous and one half as cupric sulphide*, with little lead and iron, but a notable amount of zinc. The analysis agrees with the formula—

$$\{\tfrac{2}{3}Cu'_2S + \tfrac{7}{3}(Cu'' + Zn + Fe + Pb)S\}.Sb_2S_3.$$

The mineral might as well be considered a distinct species as stylotypite, but it is probably better to avoid multiplication of names, and to consider both merely as varieties of Bournonite.

(90.) *Analysis of Colourless Mimetite from the "Richmond" Mine, Eureka, Nevada.* By F. A. MASSIE, of the University of Virginia.

The specimen consisted of slender, almost acicular, hexagonal prisms, aggregated into a fragile mass, with a few small crystals of wulfenite scattered through it. The individual crystals were colourless and transparent, with adamantine lustre and white streak; the general aspect of the mass very much like that of cerussite. Hardness = about 3. Sp. gr. = 6·92. Very easily fusible. Analysis gave—

As_2O_5	23·41
P_2O_5	trace
PbO	68·21
$PbCl_2$	8·69
	100·31

in accordance with the well known formula—

$$PbCl_2.3Pb_3As_2O_8.$$

(91.) *Examination of Gold, Silver, &c., Alloys found in grains along with the Native Platinum of Colombia, S. America.* By W. H. SEAMON.

Some years ago I had an opportunity of picking over, with the aid of a lens, two pretty large parcels of South American native platinum, and selecting for examination a number of grains which had not the appearance of platinum or osmium-iridium. These grains of foreign material were examined by Mr. Seamon, who first carefully separated those presenting visible difference of external character. In doubtful cases single grains only were submitted to analysis. Quartz, pyrite, chalcopyrite, and one or two particles of platinum of unusual surface colour were identified, but the principal material consisted of about a gramme of metallic grains which, on being separated, gave the following results:—

(*a*) Rough, flattened grains, of greenish yellow colour and metallic lustre. Sp. gr. = 15·4. Consisted of—

Au	84·38
Ag	13·26
Cu	1·85
Pt	trace*
	99·49

* Probably mechanically imbedded.

or pretty nearly—

$$(Ag+Cu')Au_3.$$

(*b*) One grain, nearly spherical, of greenish yellow colour, metallic lustre, and sp. gr. = 15·63, consisting of—

Au	80·12
Cu	15·84
Ag	2·27
Fe	trace
	98·23

or nearly in the ratio—

$$(Cu'+Ag)_2Au_3, \text{ or } (Cu'+Ag)_4Au_6.$$

(*c*) Rounded microscopic nuggets, of honeycombed structure, light yellow colour, bright metallic lustre, and sp. gr. = 15·8, consisting of—

Au	84·01
Ag	7·66
Hg	7·06
	98·73

or nearly—

$$(\tfrac{2}{3}Ag+\tfrac{1}{3}Hg')Au_4, \text{ or } (Ag+Hg')_2Au_8.$$

(*d*) Lenticular grains of gold-yellow colour, bright metallic lustre, and sp. gr. = 15·51, yielding—

Au	93·12
Ag	4·78
	97·90

(*e*) Rough grains, of very small size, one of which was nearly spherical. Of gold-yellow colour and metallic lustre. Sp. gr. undetermined. Consisted of—

Au	about 91·00
Ag	„ 9·00
	100·00

(*f*) Rough yellow grains, with microscopic reddish spots on the surface, of full metallic lustre, and sp. gr. = about 15, consisting of—

Au	82·00
Ag	17·70
Cu	trace
	99·70

or nearly—

$$Ag_2Au_3, \text{ or } Ag_4Au_{10}.$$

The specific gravity determinations are not of much value, on account of the very small scale on which the weighings had to be made. Careful qualitative search was in each case made for the metals of the platinum group. A gold, silver, and mercury alloy from this region, though with more mercury than occurs in (*e*) has been already described. I have never seen mentioned a native alloy of gold and copper with nearly so large a proportion of copper as in (*b*).

(92.) *Analysis of Native Palladium-Gold from Taguaril, near Subara, Province of Minas Geraes, Brazil.* By W. H. Seamon.

It seems that the native gold alloyed with palladium ("*ouro preto*"), which formerly was collected in considerable quantity in Brazil, is now scarcely ever received at the Rio de Janeiro Mint, and is merely washed out from river gravels in a very small way by the poorest class of labourers working on their own account. I am indebted to Prof. Orville A. Derby, Director of the Geological Survey of Brazil, for special trouble taken in procuring me a good specimen of this alloy in the district in which it occurs.

The gold is quite finely divided, much of it true gold *dust*, the grains of larger size flaky. It has the characteristic dark or bronze-like colour due to the presence of the palladium. Sp. gr. = 15·73. Analysis gave—

Au	91·06
Pd	8·21
Ag	trace
Fe	trace*
	99·27

* Apparently as mechanically adherent Fe_2O_3.

Taking the atomic weights of gold and palladium as usually accepted, these results correspond almost exactly to the formula—

$$PdAu_6.$$

(93.) *On the Composition of Two Specimens of Jade.* By C. L. Allen, of Charleston, South Carolina.

(*a*) The former of these two specimens has some degree of special interest, as having come from one of the quarries formerly worked by the Chinese in the Karakash Valley, on the southern borders of Turkistan, representing, therefore, Chinese jade from one of its original sources. The specimen was received from the Museum of the Indian Geological Survey at Calcutta, and had been brought back among the collections of the Yarkand Embassy. The circumstances of occurrence of the mineral, and the condition of the old workings when visited have been described by Dr. Ferd. Stoliczka, naturalist, attached to the Embassy.* He says that these quarries, in the Kuenlún Mountains, must have yielded a considerable portion of the jade of Chinese commerce, and have been known to the Chinese for the last 2000 years, their working having, however, been discontinued since the expulsion of these people from Yarkand in 1864.

The mineral forms a compact, extremely tough mass, of very pale sea-green colour, and lustre between vitreous and pearly; streak white. Translucent. Hardness = 6·5. Sp. gr. = 2·98. Analysis gave—

SiO_2	57·35
Al_2O_3	1·03
FeO	1·22
MgO	22·73
CaO	13·40
Na_2O	0·25
K_2O	0·23
H_2O	2·69
	98·90

(*b*) The other specimen consisted of fragments from larger masses which had been ground and polished, and came from Hokotika, on the west side of the South Island, New Zealand, purchased from Ward and Howell, Rochester, N.Y., having been brought from New Zealand by Mr. Ward not long since.

This specimen also represented a very tough, compact substance, but of various shades of green colour, mostly dark, with lustre between vitreous and pearly; streak white. Sub-translucent. Hardness = a little over 6. Sp. gr. = 3·026. The purest portions, of uniform dark leek-green colour, were selected for analysis, which gave—

SiO_2	56·34
Al_2O_3	1·60
FeO	4·86
MgO	20·23
CaO	13·51
Na_2O	0·27
K_2O	0·31
H_2O	3·57
	100·69

* *Records of the Geological Survey of India*, vol. vii., pt. 2, p. 51 (1874).

It is obvious that both these specimens represent the "nephrite" variety of amphibole, not the aluminous "jadeite" of Damour. (*a*) corresponds essentially to the meta-silicate—

$$(\tfrac{7}{10}Mg+\tfrac{3}{10}Ca)SiO_3,$$

and (*b*) to—

$$(\tfrac{2}{3}Mg+\tfrac{1}{3}Ca)SiO_3.$$

In the former nearly all, in the latter about two-thirds, of the hydrogen of water found seems to be basic.

(94.) *On the Occurrence of Nitrites in Human Saliva.* By R. N. Musgrave.

It has been stated by Schönbein* that ordinary mixed saliva usually, but not always, gives the reaction for nitrites with starch-paste, potassium iodide, and dilute sulphuric acid. In connection with a research carried out for the U.S. National Board of Health on the methods for the determination of organic matter in potable water,† I was led to think of re-examining this point, having come to suspect the possibility of an organised nitrifying ferment being the cause of disease from the use of certain waters in which nitrites and nitrates were prominently detectable, though the quantity of organic matter was small, while Dr. Sternberg, U.S.A.,‡ had observed marked, even fatal, effects upon rabbits from the sub-cutaneous injection of some specimens of human saliva. Mr. B. H. Heyward had last year examined under my direction into the occurrence of ammonia in saliva,§ and found it present in all the cases examined, thus suggesting a possible source for the production of nitrites and nitrates under the influence of organised ferments in the secretion in question. Mr. Musgrave undertook to investigate the occurrence of nitrites, and, although his work was cut short before it had covered the ground intended, the following results were obtained, which deserve to be recorded:—

The admirably delicate test of Griess—sulph-anilic acid followed by naphthylamin hydrochlorate in an acidified solution—was employed, and quantitatively applied by comparison of the colour produced under precisely similar conditions by the saliva on the one hand, and a standard (extremely dilute) solution of pure potassium nitrite on the other. Due care was taken to avoid error from nitrites derived from the air. Examining at about the same hour of the day—10 to 11 a.m.—the mixed saliva of different individuals—all young men, students, in good health—the results were:—

Parts of Nitrogen as Nitrites per million of Saliva.

First person	2·0
Second person	0·7
Third person	0·8
Fourth person	0·4
Fifth person	0·4
Sixth person	1·3
Seventh person	0·8
Eighth person	1·0
Ninth person	1·2
Tenth person	1·2
Eleventh person	0·9
Twelfth person	1·6

The results varied on different days for the same person: thus, on other days than those of the above experiments, the first person gave 1·6 parts per million, and the second person 1·3 parts. Apparently there was a relation between the interval of time from meals and the results obtained. Thus, in the case of the first person in the list, on one day the results were—

Pts. per million.

Before breakfast	0·0
After breakfast (10 to 11 a.m.)	2·2
Later (1 to 2 p.m.)	1·3

And on another day—

Before breakfast	0·7
After breakfast (10 to 11 a.m.)	1·6

While the third person in the list gave—

Before breakfast	0·0
After breakfast (10 to 11 a.m.)	0·8

It had been intended to examine the secretions of the different salivary glands separately, but this was not done.

It will be observed that the amount of nitrogen found as nitrites is much less than that as ammonia, Mr. Heyward having determined quantities of the latter varying from 30 to 100 parts per million.

University of Virginia,
August 30, 1882.

* *Journ. für Prakt. Chem.*, 86, 151.
† *Bulletin of the U.S. National Board of Health*, Suppl. No. 19, (May 27, 1882).
‡ Same *Bulletin*, No. 44 (April 30, 1881), and Suppl. No. 14 (July 23, 1881).
§ Chemical News, vol. xliv., p. 208.

ON SAUER'S METHOD OF ESTIMATING SULPHUR, AND SOME MODIFICATIONS.

By W. G. MIXTER.

Several years ago, A. Sauer* and the writer† proposed methods for determining sulphur in coals and organic compounds by burning in oxygen and oxidising the sulphur dioxide with bromine. The former passed the products of combustion through two U-tubes containing a hydrochloric acid solution of bromine, and the latter burned in a confined volume of moist oxygen and a little bromine vapour. The writer stated that experiments made by passing the products of combustion of sulphur compounds through nitric acid failed to give satisfactory results. A variable loss was due to a dense white fume containing sulphuric acid, which was not completely absorbed by water or by caustic alkalies. It was mentioned that the apparatus employed was designed to avoid this source of error.

With the hope that Sauer's method or some simple modification of it would give satisfactory results, the following experiments have been made. For the burning of volatile substances, Sauer's plan of a doubly perforated rubber stopper in the anterior end of the combustion-tube did not seem desirable, as some sulphuric acid is liable to condense with the water against this stopper; or in case little water is present, some strong sulphuric acid may come in contact with the rubber; hence oxygen was passed through the small hard glass tube *a*, fig. 1, to *c*. Carbonic acid or air was passed in very slowly through *b* during the volatilisation of the assay to prevent the condensation in the cold anterior end of the combustion-tube. After all volatile matters had burned, the rubber tubes, connecting with the oxygen and carbonic acid supplies, were closed by clamps and reversed, so that on opening the clamps oxygen passed through *b*, and a very slow current of carbonic acid through *a*. The products of combustion were passed through two U-tubes, such as figured by Sauer, containing a solution of bromine in a mixture of one part of fuming hydrochloric acid and two parts of water. In order to find whether the cloud which issues from the U-tubes contains sulphur, it was passed by means of a glass tube to near the bottom of an eight-litre bottle. This cloud or fume usually has a well defined surface, which seldom rises above the middle of the bottle. After the cloud completely subsided, the bottle was rinsed three times with water, and the sulphur was precipitated as barium sulphate. Sauer's plan for non-volatile substance was tried, with the addition of the large bottle above described. In all the experiments the rinsings of the

* *Fres. Zeit.*, 12, 32.
† *Amer. Jour. Sci. and Arts*, 3rd. series, 4, 90.

combustion-tube were added to the solutions from the U-tubes.

	I.	II.
Pure sulphur taken ..	0·2010	0·2638
Total sulphur found	99·69 per cent.	99·85 per cent.
Sulphur found in bottle	0·89 ,,	0·25 ,,
Time of burning ..	1 hour.	15 minutes.

About four times as much oxygen and carbonic acid were used in I. as in II.

	I.	II.
Coke	2 grms.	2 grms.
Total sulphur found in gaseous products ..	0·79 per cent.	0·78 per cent.
Sulphur found in bottle	0·13 ,,	1·17 ,,

In order to find whether there is any loss of sulphur in estimating it by this method in substances like coke, a mixture of sugar charcoal and pyrite, FeS_2, containing a known amount of sulphur,* was tried.

Fig. 1.

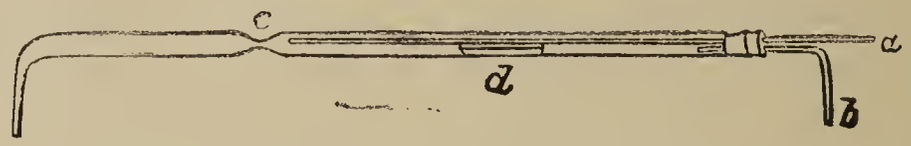
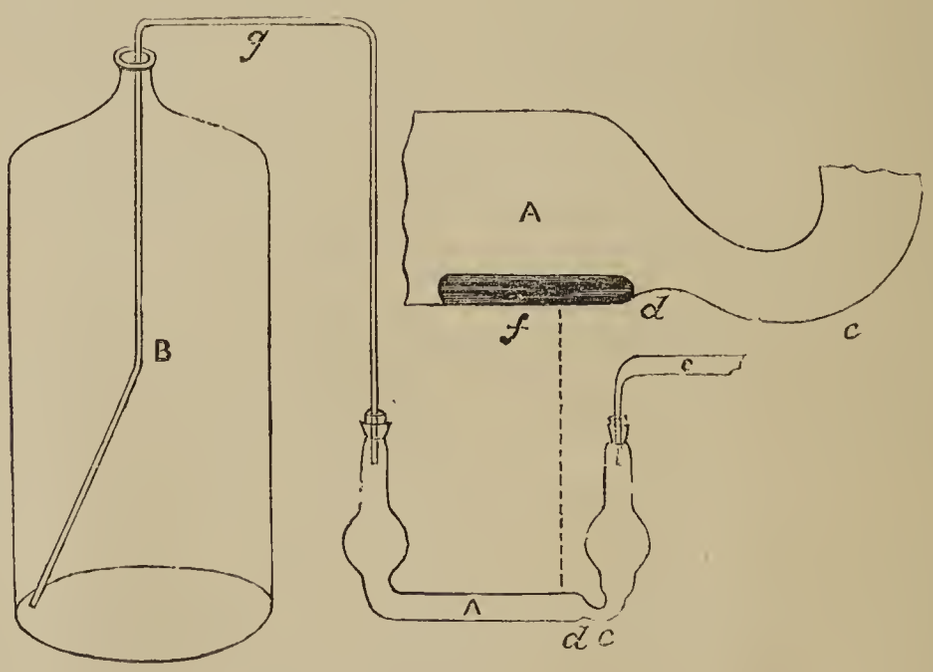


Fig. 2.



	I.	II.
Charcoal	2 grms.	2 grms.
Pyrite	0·2258 ,,	0·2057 ,,
Sulphur calculated ..	0·1199 ,,	0·1092 ,,
Total sulphur found ..	0·1198 ,,	0·1091 ,,
Sulphur found in bottle	0·0131 ,,	0·0099 ,,

The results show that in I. 99·91, and in II. 99·90 per cent was found of the sulphur taken, and that 11 per cent in I. and 9 per cent in two passed into the large bottle. No sulphur was found in the residue in the tray. The time of the actual burning of each of the assays was about three-quarters of an hour.

In the two following experiments the products of combustion were passed through 75 c.c. of fuming hydrochloric acid, saturated with bromine, distributed in three bulbs of an absorbing apparatus, each bulb having a capacity of 200 c.c., and so arranged that the gases bubbled through the liquid in each bulb and finally passed into the large bottle. The apparatus was made entirely of glass to avoid any question of sulphur from rubber connections. The burning in each test occupied about three-quarters of an hour. The results show that about two parts in one hundred parts of sulphur used were not absorbed by the bromine solution.

Charcoal	2	2	grms.
Pyrite	0·2058	0·219	,,
Sulphur found in bottle.. ..	0·0018	0·0023	,,

A hydrochloric acid solution of bromine is probably a no better absorbent of sulphur dioxide than bromine water, and is objectionable for the reason that the excess of hydrochloric acid must be evaporated so that some barium sulphate may not remain dissolved. Bromine water with a cubic centimetre or two of undissolved bromine, in a common two-bulb U-tube, loses bromine rapidly when gas bubbles through it, but when the liquid bromine mixes gradually with the water, the passing gas removes the bromine slowly. In the two following experiments, a four-bulb U-tube with two bulbs on the bottom was used. Two cubic centimetres of bromine were placed in the lower bulb next to the combustion-tube, and sufficient water was added to trap three of the bulbs. It was necessary to shake the U-tube occasionally during the combustion in order to keep bromine distributed through the water. The large bottle was used as before. A trace of sulphur found in the residues in the tray was weighed

* The pyrite was treated with cold nitric acid, and the whole was kept cool in water, and by constant agitation until only finely divided sulphur remained. On heating in a water-bath the sulphur disappeared and a complete solution resulted. The excess of acid was evaporated, the sulphur was precipitated as $BaSO_4$, the precipitate was fused with sodium carbonate. The fused mass was washed and the sulphur was re-precipitated in the acidified filtrate.

	I.	II.	
Pyrite taken	0·3230	0·3165	mean.
Per cent sulphur found ..	53·14	53·08	53·11

with the total sulphur. The time of actual burning was about three-quarters of an hour.

	I.	II.	
Charcoal	2	2	grms.
Pyrite	0·2024	0·2087	,,
Sulphur calculated	0·1075	0·1108	,,
Total sulphur found	0·1071	0·1108	,,
Sulphur found in bottle	0·0062	0·0026	,,

These figures show that 99·63 and 100 per cent of the total sulphur taken was found, and that 5·77 and 2·35 per cent respectively condensed in the large bottle, and also that bromine water may replace a hydrochloric acid solution of bromine.

After experimenting with various forms of U-tubes, designed for keeping bromine distributed through the water during the passage of the gases from the combustion, the bulb tube A, shown in fig. 2, was found suitable for this purpose. It is about 30 c.m. long and 20 c.m. high, and is narrowed at the necks so that small rubber stoppers may be used. The enlarged part represents the full size of this portion of A. The slight elevation of the glass at *d* is to keep the liquid bromine, shown at *f*, from passing into the narrowed part *e*. A description of the manner of using this absorbing tube will make clear the reasons for the shape at *d* and *e*. It is first connected with the combustion-tube *e*, and a cubic centimetre of bromine is poured in and then water added to fill it to the bulbs, and the narrow glass tube *g* is adjusted. This tube *g* dips under a little water in B. A is then slightly inclined so that bubbles of gas from the combustion may slowly pass the lower limb. From time to time, as bromine disappears from the surface of the water, A may be inclined more so that a drop or two of bromine shall enter the narrow part *e*, where the passing gas mixes it thoroughly with the water. The remaining experiments were made in the apparatus above described, and the form of combustion-tube shown in fig. 1.

	I.	II.	
Sugar	0·670	1	grm.
Sulphur	0·2028	0·2777	,,
Sulphur found	0·199	0·2747	,,
Per cent of sulphur found ..	98·12	98·95	,,

In I. a slight deposit of unburnt matter remained in the bend of the combustion-tube.

0·2783 grm. of pure carbon disulphide yielded 83·53 per cent of sulphur; theory requires 84·20. In another trial with carbon disulphide, free sulphur was found in the bromine water.

The first trial with cannel coal was a failure, owing to too rapid volatilisation. A light-coloured sticky substance containing carbon and a trace of sulphur was found in the bottle B. In a second experiment the combustion appeared to have been complete, and 3·1 per cent of sulphur was found in the volatile portion of the coal.

The results obtained show that Sauer's method is good if the sulphur which passes the bromine solution is caught in a large bottle. A much smaller bottle than the one used would probably stop all the sulphur, but an eight-litre bottle does not allow a troublesome amount of bromine to escape into the room; 150 c.c. of water are sufficient to rinse the bottle. Complete combustion can be insured by volatilising so slowly that the flame of the burning vapours remains a few millimetres back of the end of the tube delivering oxygen. Sauer's apparatus as modified by the writer, supposing a combustion furnace and gas-holders are at hand, has the advantage of simplicity and fewer connections over the plan proposed by the writer for burning in a confined space. Sauer's method requires double to treble the time for burning, and with volatile substances more care to insure complete burning than the writer's original method.—*American Chemical Journal.*

Detection of Spurious Honey.—H. Planta.—Factitious honey gives a white precipitate if mixed with honey owing to the presence of dextrine.—*Deut. Apoth. Zeitung.*

PROCEEDINGS OF SOCIETIES.

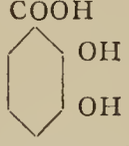
CHEMICAL SOCIETY.

Thursday, November 2, 1882.

F. A. Abel, F.R.S., Vice-President, in the Chair.

It was announced that a ballot for the election of Fellows would take place at the next meeting (November 16). The following certificates were read for the first time:—F. W. Branson, J. S. Bishop, E. E. Berry, R. Blair, R. Coulthard, W. J. Chrystal, T. R. Cowie, R. Carruthers, E. G. Clayton, J. T. Dunn, H. L. Dampier, A. G. Earl, G. Gray, J. L. Howe, A. G. Howard, W. A. L. Hammersley, H. Hotblack, E. Jackson, A. E. Johnson, A. Keen, F. J. Kilner, J. D. McCarthy, H. E. Newton, T. F. Peppé, S. E. Phillips, R H. Parker, S. Rideal, G. M. Taylor, T. E. Vasey.

Dr. A. K. Miller then read a paper "*On Dihydroxy-benzoic Acids and Iodo-salicylic Acids.*" Of the six possible dihydroxy-benzoic acids, five are already known, the sixth acid being represented by the formula—



Two methods were tried for preparing this body. 1. Catechol was heated with concentrated solution of ammonium carbonate in sealed tubes for several hours. The product of the reaction consisted of a mixture of two acids, one of which was proto-catechuic acid; the other must be the acid sought for, as this and proto-catechuic acid are the only two dihydroxy-benzoic acids derivable from catechol. The above reaction gave a very poor yield, and a second method for preparing this catechol-orthocarboxylic acid was tried. Salicylic acid and iodine were heated together in alcoholic solution, and the resulting iodo-salicylic acids purified by crystallisation from water. The results obtained differ from those published by Lantemann, Liechti, Demole, &c. It was found that two iodo-salicylic acids had been formed: para-iodo-salicylic acid, melting at 197°, and a new isomer, melting at 198°. The two differed in crystalline appearance, solubility, &c., but most markedly in yielding two distinct dihydroxy-benzoic acids when heated with potash. From the former quinol-carboxylic acid was obtained, from the latter an acid, which split up on heating into carbonic anhydride and catechol. The fact of a dihydroxy-benzoic acid derived from salicylic acid, splitting up on heating into carbonic anhydride and catechol is of itself proof that it must have the constitution indicated above. This constitution is, however, the only one possible for the acid produced together with proto-catechuic acid by introducing a carboxyl group into catechol, and since a comparison of the products of both reactions has shown the two to be identical there can be no doubt that constitution given is the correct one.

The Secretary then read a paper "*On Crystalline Molecular Compounds of Naphthalene and Benzene with Antimony Trichloride,*" by Watson Smith and G. W. Davis. On melting three parts by weight of antimony trichloride and two of naphthalene, minute but perfectly symmetrical clinorhombic tables formed in the liquid, after the source of heat had been removed. These crystals were separated with a warmed platinum spatula. They are very deliquescent, and have the composition $3SbCl_3,2C_{10}H_8$. A similar compound is formed with benzene having the composition $3SbCl_3,2C_6H_6$.

A second communication was also read by the Secretary, entitled "*Additional Evidence, by an Analysis of the Quinoline Molecule, that this Base belongs to the Aromatic Series of Organic Substances,*" by Watson Smith and G. W. Davis. The authors have investigated

the effect of an exhaustive perchlorination, according to the method of V. Merz, on quinoline. If this body has the constitution usually assigned to it, the portion of the compound nucleus containing nitrogen might be expected to be least stable, and to yield, when chlorinated, perchlorethane, perchlormethane, and nitrogen, whilst the other portion would yield perchlor-benzene.

$$C_9.Cl_7N + 7Cl = C_6Cl_6 + C_3Cl_8 + N'$$
$$C_3Cl_8 + Cl_2 = C_2Cl_6 + CCl_4$$

Pure quinoline was therefore heated in a strong tube of hard glass with ten times its weight of antimony pentachloride to 170°, then to 280°, to 320°, and finally to 400°, each for a space of five hours. After each heating the hydrochloric acid gas, and nitrogen were allowed to escape, an operation attended with some danger. A crystalline black mass was the result, which was washed out with hydrochloric acid, and the antimony separated. The residue was dried and sublimed. By re-sublimation, &c., perchlor-ethane, melting at 182°, and perchlor-benzene, melting at 223°, were separated. No perchlor-methane could be detected, but owing to its volatility it was probably carried off in the violent rushes of gas which took place on opening the tube.

The Secretary then communicated a paper "*On Orcin and some of the other Di-oxy-toluols*," by R. H. C. Nevile and Dr. A. Winther. Various considerations led the authors to the conclusion that orcin was a di-oxy-toluol of the constitution 1 . 3 . 5, a supposition which has since been shown to be true by Tiemann and Streng. The present research was undertaken to discover if possible some practicable method for the artificial production of orcin. The starting point was dinitro-toluol, 1 . 3 . 5, prepared from dinitro-para-toluidine the yield being 60 to 65 per cent. The dinitro-toluol was dissolved in an alcoholic solution of ammonium sulphide and water added, when an orange-red substance is precipitated. This was dissolved in dilute hydrochloric acid and reprecipitated by ammonia. The nitro-toluidin was purified, converted into nitro-kresol, which was reduced with tin and hydrochloric acid. The chloride was dissolved in a hot mixture of equal parts of sulphuric acid and water. The solution diluted with water, and a dilute solution of potassium nitrite added. The liquid was then warmed, filtered, and extracted with ether. The red-brown oil so obtained was purified by distillation, and the product by crystallisation furnished the di-oxy toluol identical in all respects with orcin. The authors have also prepared orcin from meta-bromo-toluol-meta-sulphonic acid, and from meta-dibromo-toluol. The authors have also prepared the di-oxy-toluol, 1 . 2 . 4 and 1 . 2 . 5, and have investigated the preparation of the body 1 . 3 . 4. They have tabulated the reactions of the various di-oxy-toluols with ammonia, chloride of lime, ferric chloride, &c.

"*On the Varying Quantities of Malt Albumenoids Extracted by Waters of Different Types*," by E. R. Moritz and A. Hartley. The authors give tables showing the sp. gr. of the worts and the percentage of nitrogen extracted by distilled water, and waters containing NaCl, $MgSO_4$, Na_2CO_3, Burton crystals, $Ca(NO_3)_2$, &c. The experiments show that distilled water extracts the smallest amount of albumenoids; salt does not much increase the extractive power, but calcium salts, especially the nitrate, have a strong extractive power. The authors, however, conclude that the influence of the extracted albumenoids has been very much overrated, as the differences in results are comparatively insignificant. They attribute the characteristics of the finished produce to the direct influence of the mineral matters on fermentation, a subject which they are at present investigating.

Mr. Warington suggested that the authors might have carried their investigations further, and estimated the non-albumenoid as well as the albumenoid nitrogen. The extract might have been precipitated by phospho-tungstic acid, and the nitrogen determined in the filtrate.

"*On the Derivatives of Ethylene Chloro-bromide*," by J. W. James. The author summarises his principal results as follows:—When preparing ethylene chloro-bromide by passing the gas into a solution of chloride of bromine (ClBr), it is necessary, to obtain a pure product and a good percentage, that the chlorine be passed into the bromide at 0° C., otherwise a substance is formed boiling 3° or 4° higher than pure C_2H_4ClBr, which is useless for the advantageous preparation of ethylene chloro-thio-cyanate. If an aqueous solution of neutral sodium sulphite and ethylene chloro-thio-cyanate be brought together in direct sunlight, the sodium salt of a new acid, ethylene thio-cyano-sulphonic acid,—

$$C_2H_4 \begin{cases} SO_3H \\ SCN \end{cases}$$

is produced. By passing ammonia gas into an ethereal solution of chlor-ethyl-sulphonic chloride no amide is formed; with ethyl-sulphonic chloride, however, the corresponding amide is easily obtained. By the action of neutral sodium sulphite in aqueous solution upon ethylene di-bromide or chloro bromide, isethionate of sodium is produced with evolution of sulphurous anhydride, in addition to the well-known ethylene disulphonate of sodium obtained by Strecker.

After the thanks of the meeting had been given to the authors for their respective papers, the Society adjourned to November 16, when a ballot for the election of Fellows will be held, and the following paper was announced to be read: "Contributions to the Chemistry of Tartaric and Citric Acids," by the late B. J. Grosjean.

CORRESPONDENCE.

AN EXAMINATION QUESTION.

To the Editor of the Chemical News.

Sir,—The following question appears in the Chemistry Paper set at the Examination for the Licence of the Royal College of Physicians, 1st Part, October, 1882.

"4. 100 grms. of pure marble are treated with excess of hydrochloric acid. The gas evolved is dried and passed through a tube containing 100 grms. of pure lime. To what extent does the lime increase in weight?"

If this be given as a *catch* question it seems hardly fair thus to tempt the unwary candidate to his destruction; and if it be set in good faith, how can it be reconciled with the observation made long ago by Scheele that "anhydrous lime does not absorb carbonic acid, provided no water has access to it." (Gmelins's "Handbook," translated by Watts, iii., 185)?

A Student of Chemistry.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherw expressed.

Moniteur Scientifique, Quesneville.
August, 1882.

Conclusions of a Report on the Metallurgy of Lead and Silver at Leadville, Colorado.—Antony Guyard.—From a Report on the Geology and Mining Industry, by S. F. Emmons, of the U.S. Geological Survey.

Determination of Zinc by Means of a New Reagent and its Separation from the Alkalies, Lime, Magnesia, Manganese, Copper, Nickel, and Cobalt.—Antony Guyard.—The reagent employed is crude ammonium sulpho-carbonate and is obtained by placing in contact for

some days, with frequent stirring, concentrated ammonia and carbon disulphide. When the mixture has acquired an intense yellowish red colour and a slight excess of carbon disulphide remains undissolved—when a drop of the liquid produces in an ammoniacal and slightly concentrated solution of a salt of nickel a precipitate which is purple by reflected and green by transmitted light—the reagent is ready for use. It must not be diluted with water, since the precipitate obtained is the more dense and granular as the solutions are more concentrated. A known weight of the zinc ore is dissolved in acids and treated with the ordinary mixture of sal-ammoniac, ammonia, and ammonium carbonate, to separate, iron, lead, lime, &c., and to the clear filtrate there is added a slight excess of crude ammonium sulpho-carbonate, until it appears of a decided reddish yellow. The zinc is precipitated as a very dense, granular, pale yellow deposit, absolutely insoluble in an excess of the reagent. The precipitation is performed at 66° to 80°, and the liquids must not under any circumstances be raised to a boil. The zinc sulpho-carbonate is collected on a double filter, and well washed with luke-warm water, and is then dried at 100° to 110°. At this temperature it is completely transformed into zinc sulphide, which, from its density, is not oxidised on contact with the air. The zinc may be either weighed in this form or it may be ignited in a current of sulphuretted hydrogen according to Carnot's process, or it may be transformed into oxide. The analytical value of this method depends on the fact that the zinc is entirely thrown down in a state which admits of easy collection and washing, and is at the same time completely separated from lime, magnesia, manganese, copper, nickel, and cobalt. Although this process is applicable in the analysis of bronze and brass, the author only recommends it for analysis of minerals containing an excess of zinc. Pure ammonium sulpho carbonate is of no use, since the presence of a certain quantity of ammonium sulphide is essential.

A New Antiseptic Compound and its Use in the Preservation of Alimentary Substances.—Prof. F. Barff.—From the *Journal of the Society of Arts*.

New Process for the Volumetric Determination of Zinc.—Antony Guyard.—When zinc and copper occur together in an ammoniacal solution, and we pour into this mixture a solution of potassium cyanide, this latter body only acts upon the copper when it has completed its action upon the ammoniuret of copper, so that the disappearance of the blue colour indicates the end of the reaction. If an unknown quantity of zinc contains a known weight of copper, or a known volume of a solution of copper, the strength of which has been previously determined by means of the solution of cyanide, then by subtracting the number of degrees of the burette necessary for the copper alone from the total number required for the mixture of zinc and copper. It is necessary to effect each determination under identical conditions of volume, temperature, concentration, and the nature and quantity of ammoniacal salts ought to be the same in the liquids.

New Process for the Volumetric Determination of Sulphuric Acid, Free or Combined.—A. Guyard.—The author prepares a normal solution of lead nitrate by dissolving an equivalent (in grammes) of this body in a litre of water. The solution containing sulphuric acid, sulphates, or a mixture of both, is placed in a burette graduated into tenths of a c.c. There are poured into a beaker, provided with a stirrer, 25 c.c. of the normal lead solution, and it is coloured a bright yellow by means of some drops of potassium iodide. We pour then gradually and stirrring incessantly the sulphuric solution from the burrette till the liquid in the beaker is completely decolourised. The number of divisions employed correspond exactly to the weight of sulphuric acid necessary to precipitate 25 c.c. of the normal solution of lead nitrate. This process is advantageous chiefly for determining the total acid. If it is desired to determine both the free and the combined acid, the best process is the following:—Total acid is determined as above, and the free acid is then found by means of a standard ammoniacal solution of copper. The difference is the combined acid. These processes are recommended only when there is no other free acid except the sulphuric, and when the liquids in question contain mere traces of chlorides.

Preparation of Oxygen at the Common Temperature.—A. Guyard.—The author obtains oxygen in the cold by the action of concentrated nitric acid upon potassium permanganate. The gas is given off with great regularity, and if washed in a weak alkaline solution is absolutely pure.

Note on the Determination of Copper as Subsulphide.—A. Guyard.

Determination of Nickel as Sulphide.—A. Guyard.

Sulphurous Acid considered as a Reducing Agent.—A. Guyard.

New Process for Separating Ferric Oxide from Alumina and Titanic Acid.—A. Guyard.—These four last papers are taken from the *Scientific American*.

Fixation of Certain Artificial Colouring-Matters by Metallic Mordants.—H. Kœchlin.—This paper will be inserted at length.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Peroxide of Hydrogen.—Will any of your readers inform me or refer me to the best and cheapest way to manufacture this article on a large scale for use as generated in the liquid state?—Reader.

Mildew.—Will any of your readers refer me to the best authority on mildew, its cause and prevention, more especially in printed calicoes, as I can find no account of it in some of the leading chemical books?—H. C.

["Sizing and Mildew in Cotton Goods," by G. E. Davis, C. Dreyfus, and P. Holland. Manchester: Palmer and Howe. "The Sizing of Cotton Goods and the Causes and Prevention of Mildew," by W. Thomson. Manchester: Heywood.]

MEETINGS FOR THE WEEK.

Thursday, 16 h.—Chemical, 8. Ballot for the election of Fellows. "Contributions to the Chemistry of Tartaric and Citric Acids," by the late B. J. Grosjean. "Contributions from the Jodrell Laboratory, Kew. (1) Constitution of Lignin and Bastose, by C. F. Cross and E. J. Bevan; (2) Contributions to the Chemistry of Plant Fibre, by C. F. Cross, E. J. Bevan, and S. S. Webster; (3) Action of Nitric Acid on Cellulose, by C. F. Cross and E. J. Bevan." "On the Constitution of some Bromine Derivatives of Naphthalene," by R. Meldola.

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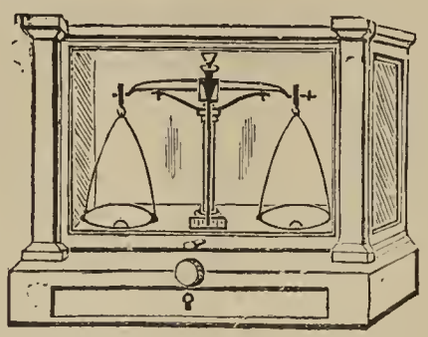

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THE CHEMICAL NEWS.

Vol. XLVI. No. 1199.

TESTING FOR BARIUM OR SULPHURIC ACID.

By SPENCER PICKERING, B.A. (Oxon).

A determination of the delicacy of the barium sulphate test gave the following results:—

The minimum strength of a solution of barium chloride in which the barium could be detected with certainty was found to be one containing 0·0000012 grm. of barium (=0·00000135 grm. BaO) per c.c., or 1 part of barium in 833,000 parts of water. As the cloudiness produced can easily be seen with 2 c.c. of the liquid it follows that the actual amount of barium which can thus be detected is 0·0000024 grm.; equal to 0·0000027 grm. BaO.

In the testing sulphuric acid was used; the reaction did not appear to be rendered more delicate by using alkaline ammonium sulphate; the reagents were left in contact for 5 or 10 minutes before the result was examined.

The best results are obtained by placing an artificial light almost vertically above the test-tube containing the liquid, and a black background behind, allowing the light to fall on a portion only of the liquid.

PYROLOGICAL NOTES.

By Lieut-Colonel W. A. ROSS, late R.A.

(Continued from p. 200.)

III. On a New Blowpipe Reagent (*concluded*).

IV. *Pyrological Analysis of Acmite.*

(12.) $SrSO_4$.—Applied a trace of powdered *celestine* to bead (11); great effervescence, after which all was dissolved to a colourless transparent bead.

(*a*.) Applied H.P. for some seconds; bead covered with flat discoidal crystals of an entirely different form from that of the previous ones; under a ¼ inch objective these were very small and extremely numerous, but all *precisely similar*, something like the rosettes on a horse's headstall.

(*b*.) With a more copious supply of celestine, and long H.P., much larger crystals than those of (*a*), solid, and in the interior of the bead appeared, but so aggregated that it was difficult to distinguish the form.

(13.) $CaSO_4+2H_2O$.—Two fragments of *selenite* to a fresh bead P.P. dissolved rapidly; not so much effervescence as (12) to a transparent colourless bead.

(*a*.) After H.P. large twin crystals or macles, polarising slightly, of a perfectly different form.

(*b*.) After strong O.P., and the bead allowed to cool (comparatively), in an "atmosphere" of ignited hydrogen (or in H.P.), fine, large, solid crystals in interior of bead; polarising well. In a ¼ inch objective, these fine crystals appeared in masses or groups, none separately formed, but all in macles, apparently belonging to the cubic system (*gypsum* crystallises in nature, in monoclinic or oblique forms).

(14.) $MgCO_3$.—A trace of *magnesite* to a fresh bead, dissolved rapidly by O.P. with effervescence, to a transparent colourless bead.

(*a*.) The merest touch of H.P. rendered this bead nearly opaque, with minute star-like crystals, differing in form from all previously seen, but all precisely like each other.

(*b*.) After strong O.P., and bead cooled in H.P. a confused mass of flat or tabular crystallisation, with apparently many perfect circles (!) and curious combinations of angles and circles.

(*c*.) With more $MgCO_3$ and strong H.P., there was little or no effervescence (!) and no crystals; but, upon adding some more of this flux, H.P., the bead became quite blue, and some large and well-defined prismatic crystals appeared in the interior, with a large mass of indistinct crystallisation; transparent, but not polarising

(15.) MnO_2 dissolved in a fresh bead, afforded in P.P. the usual amethystine bead; in O.P., reddish; in a weak H.P., reddish (!), and in H.P., colourless (shows that the flux retains oxygen).

(16.) $BaCO_3$ dissolved in a fresh bead in considerable quantity by O.P., without much effervescence, to a transparent colourless bead.

(*a*.) After a little H.P., large, flat, transparent crystals formed, polarising well. In a ¼-inch objective, these appeared in symmetrical groups, something like a roughly-drawn butterfly; all similar.

(*b*.) With a greater supply of $BaCO_3$ in H.P., a mass of transparent crystallisation was formed, polarising well, but the forms quite indistinct.

(*c*.) When more of the flux was added to *b*, after some difficulty crystals were formed by H.P., chiefly separate, but with edges rounded and indistinct; apparently a kind of compromise between an angle and a circle.

Acmite.—"*Pyr.*, *&c.*, B.B. fuses at 2, to a lustrous black, magnetic globule, colouring the flame deep yellow, and with the fluxes reacts for iron, and sometimes manganese."—"Dana's Syst. Min.," page 224.

Acmite.—*Pyr.*, *&c.*—1. Powder in boric acid O P. part dissolved to an opaque, dark brown bead, with complete yellowing of the green pyrochrome (probably an iron mineral with large proportion of soda); on addition of cobalt oxide O.P., cobalt borate dissolved, with a pink suffusion over the bead (over 10 per cent of alkali); on addition of lime powder O.P., no milkiness (no alumina). 2. Powder of a fused fragment, boiled and dried, in phospho-boric acid* O.P.; about three-fifths unattacked sharp semi-transparent fragments (about three-fifths silica); about one-third black-brown opaque balls with rust-like matter (about one third iron); a few brown transparent balls, colourless after H.P. (a little manganese); one or two transparent balls; clear, hot; pale green, cold (trace of lime containing iron protoxide; no magnesia); one or two yellow fragments, blue after H.P., and producing a pale amethyst colour in a P. acid† glass, H.P. (trace of titanium). 3. Powder of (2) in pink P., acid O.P., about three-fifths undissolved (about three-fifths silica, consequently little or no alumina); bead remains pink (little or no alumina); with powder of (1) O.P. bead violetish blue (over 10 per cent of alkali).

Analysis by Berzelius of Acmite from Rundemyr.

SiO_2	55·25
Fe_2O_3	31·25
MnO_2	1·08
CaO	0·72
Na_2O	10·40
TiO_2	trace
	98·70

(To be continued.)

* Made by dipping the red-hot boric acid bead for a second in deliquesced, pure phosphoric acid.

† "P. acid" = "glacial" phosphoric acid.

THE ABSORPTION OF METALLIC OXIDES BY PLANTS.*

By FRANCIS C. PHILLIPS.

THE question how far the vital processes of plants are influenced by the various mineral compounds presented by the soil to their roots has long been under discussion in physiological botany, but further than to establish the fact that the presence of certain compounds in soil tends to increase the nutritious elements, and promote the growth of particular vegetables, little has been done towards a complete solution of the problem.

It is well known that potash tends to increase the quantity of starch, that silica strengthens the stems of the grasses, that oxide of iron is essential to the production of leaf-green, that phosphates increase the fertility of the soil for cereals, but even as regards these constant elements of every soil, very little can be positively asserted of the precise influence of any one, in the economy of the plant.

Concerning the part played by the rarer elements, cæsium, rubidium, copper, nickel, manganese, zinc, and barium, in the assimilation of carbon, nitrogen, and the functions of nutrition, and whether they are beneficial or injurious, nothing whatever is known, although modern refinements in chemical methods have led to their frequent detection both in soil and in plants. That so important a problem should have remained almost wholly unsolved must be attributed chiefly to the very great difficulties which are met in any experimental investigation, but also to the fact that the few investigations published have been carried out, in most cases, for the purpose of proving that vegetation had been injured by metallic compounds traceable to a metallurgical works, and with the special purpose of founding a claim for damages, rather than to solve a scientific problem. The study of the influence of metallic compounds on plants has recently acquired great practical importance, from the fact that many manufacturing processes, more especially those employed in the smelting of lead and copper, and arsenical ores of various metals, have given rise to a gradual impregnation of the soil with such metals, and to the consequent poisoning of vegetation and animals.

In almost all cases where furnaces for the treatment of such ores have been erected, there has followed a serious injury to vegetation, caused by the metallic vapours and dust escaping from the flues; while the lawsuits instituted to recover damages have brought forward many interesting facts as to the extent of vapourisation of metals, the necessity and difficulties of providing proper means for condensing the noxious fumes, the evidence has seldom furnished any definite information as to the more general question at issue.

The possibility of injury to plants from such sources has been denied under an assumption that plants, like animals, possess a certain discriminating power, and that they are able to select and take up through their roots, such elements of the soil as are nutritious, and to reject all else, a view which is very commonly accepted, and has been held by high authorities.

With the very much less complete condensing apparatus in use in former times, the injury caused by such establishments was far greater than at present, but even at smelting works where the most improved machinery is in use, it is often difficult to prevent the escape of large quantities of poisonous mineral compounds, which in the shape of dust may be carried many hundred yards and scattered with injurious effects upon vegetation.

As early as the year 1668 mention is made of the injury to pastures, caused by lead fume, by Joseph Glanvil, who published a description in the *Philosophical Transactions* of the smelting of lead ores in the Mendip Hills.

This author says "there is a flight in the smoak, which, falling upon the grass, poysons those cattel that eat of it. They find the taste of it upon their lips to be sweet, when the smoak chances to fly in their faces. Brought home and laid in their houses, it kills rats and mice.

"If this flight mix with the water in which the oar is washed, and be carried away into a streame, it hath poysoned such cattel as have drunk of it after a current of three miles."

Richard Watson, in his "Chemical Essays," published in 1793, calls attention to the saving to be effected, and the protection afforded to pastures, by the use of long horizontal chimneys, for the condensation of lead fume, in Derbyshire.

"But so difficult is it," says this author, "to wean artisans from their ancient ways that I question whether any of them would ever have adopted the plan they approved, if an horizontal chimney which was built in Middleton Dale to protect pastures from the smoke of the furnace had not given them full proof of the practicability of saving the sublimate of lead which is lost in the ordinary method of smelting."

Among more recent cases, the following, cited by Taylor, in his "Treatise on Poisons" (3rd American edition, p. 424), is of interest: "It was alleged on the part of the plaintiff that a large number of sheep and cattle had been destroyed by fumes of lead escaping from a chimney on the defendant's works. The case involved this curious point, namely: admitting the sheep and cattle to have been destroyed by lead, whether the lead was deposited on the herbage from the defendant's chimney, or taken up by the plants from the soil, and incorporated with their tissues. The condensing arrangements at the lead works were found to be almost absolutely complete, and there was not the slightest appearance of a deposit of white-lead on the herbage. But it was found that the herbage was impregnated with lead, and that seeds sown in the leaden soil, brought for this purpose to London, produced plants containing lead. The soil had derived the lead from ancient mineral workings."

Dr. Wilson (*Edinb. Monthly Journal of Medicine*, 1852), in a case somewhat similar to that cited by Taylor, of cattle poisoning by lead, found the herbage to contain the metal, and that beans grown upon a portion of the soil were impregnated in the same manner.

The results seem to point very clearly to the possibility of the absorption of lead by the roots of plants.

An exhaustive investigation into the action of copper and zinc on vegetation has been made by Dr. Freytag, of the Agricultural Laboratory in Bonn,* and the results published in an official report upon the injury alleged to have been caused by the smelting furnaces of Mansfield. In the neighbourhood of Mansfield, furnaces have been in operation for several centuries, and the soil in many places has in consequence become greatly deteriorated as regards its fertility, being charged with as much as 10 lbs. of oxide of copper and 24 lbs. oxide of zinc, to the ton of earth. In order to test the influence of these metals upon the nutritive qualities of the crops, Freytag made comparative analyses of clover and grass grown in the neighbourhood of the smelting furnaces, and of similar plants grown five miles distant, but under as nearly as possible the same conditions of temperature, moisture, and manuring. The plants from the neighbourhood of the furnaces differed in the following points from those grown at a distance.

1. They contained in their ashes varying quantities of the oxides of copper and zinc, as much as 0·2 per cent oxide of copper, and 0·36 per cent oxide of zinc.

2. There was a larger percentage of sulphuric acid,

* A Paper read before the Engineers' Society of Western Pennsylvania, Tuesday, February 21, 1882.

* "Wissenschaftliches Gutachten über den Einfluss, welchen die Hüttenwerke der Mansfelder Kupferschieferbauenden Gewerkschaft auf die Vegetation und indirect auf Menschen und Thiere ausüben.' Von Dr. Moritz Freytag. Eisleben, 1870.

attributed by Freytag to the fact that the copper and zinc occur in the soil as sulphates.

3. The proportion of nitrogenous bodies was greater by 25 to 30 per cent (2 per cent of the dried plant). As regards the assimilation of nitrogen, therefore, the metallic sulphates were apparently beneficial.

Very interesting experiments have been made by Freytag upon the capacity of plants to absorb solutions of metallic salts.

Beans, peas, and other seeds were allowed to germinate in a solution containing nutritious matters, and after maturing, were transferred to solutions containing arsenious acid, the sulphates of iron, cobalt, nickel, zinc, and copper.

The result was that a solution containing 1-80th per cent arsenious acid proved fatal, as was also the case with 1-25th per cent sulphate of cobalt, 1-15th per cent sulphate of nickel, 1-50th per cent sulphate of zinc, 1-5th per cent sulphate of iron.

No injurious effects were produced by more dilute solutions, the plants continuing to thrive until the poisonous limit of concentration was reached, when they rapidly withered and died.

In all cases there were found in their tissues small quantities of the respective metals in whose solutions they had been grown.

Freytag says: "I have found that plants growing in solutions of metallic salts are killed when the concentration reaches a certain degree, which is in all cases below 1 per cent of the solution, and this statement applies equally to those salts which are essential to plant-life. If we accept this as equally true of plants growing upon soil, it follows that the moisture of the soil must contain very small traces of mineral salts in solution, and by experiment it has been shown that the watery extract of a soil which is charged with salts of the heavy metals always contains less than the fatal dose of such metals."

Freytag thus sums up:

"It has been fully demonstrated that plants are not capable of selecting from the substances presented to their roots, that they, are on the contrary, compelled to take up all matters alike, which are in a form fitted for absorption, but that matters insoluble in the moisture of the soil are never taken up in sufficient quantities to endanger the life of the plant."

Freytag claims as his own, the theory of non-discrimination of plants, but Liebig, in his "Agricultural Chemistry" (4th English edition, p. 66), states that "all substances in solution in a soil are absorbed by the roots of plants, exactly as a sponge imbibes a liquid, and all that it contains, without selection."

Freytag has detected zinc and copper in the leaves of oaks and birch trees in the Mansfield district, and in a series of experiments it was found that zinc added to soil in the form of carbonate is absorbed by rye, wheat, and maize, and is deposited in the leaves, stems, and seeds. Many plants growing near zinc mines absorb considerable quantities of oxide of zinc, and in two well-known cases new varieties are considered to have been produced by soil containing zinc, one a shepherd's purse (*Thlaspi alpestre*, variety *calaminaris*), the other a violet (*Viola tricolor*, variety *calaminaris*).*

The latter plant is considered by some authorities to be a distinct species. The ash of the leaves of this violet contains 13 per cent oxide of zinc. Both of these plants are confined to localities where zinc is an element of the soil, and the zinc seems therefore to be an essential constituent.

Among the strongly poisonous metals, zinc appears, according to the investigations published, to be the most readily absorbed by plants. It is of singular interest, however, that experiments conducted in the botanical garden at Erlangen, have led to a negative result, as regards the possibility of its absorption, contradicting, therefore, those obtained by Freytag.

* Johnson, "How Crops Grow," p. 196.

In the report of the Commissioner of Agriculture (Washington, 1875), some experiments are described upon the action of Paris green on vegetation. Peas were sown in soil containing varying quantities of Paris green. No injurious effects were produced where the quantity of the arsenical compound was less than 900 lbs. per acre of soil. When present in larger quantity, the plants were feeble and were smaller in proportion as the arsenic was increased. With 1½ tons of Paris green to the acre the seeds failed to germinate. The plants were tested for arsenic, but were found to have not absorbed even traces of the metal recognisable by Marsh's test.

These results involve, therefore, a direct contradiction of Freytag's theories, both as regards the non-absorption of the metal, and as regards the vital processes of the plant. According to Heckel (*Comptes Rendus*, vol. lxxx., p. 1172), water containing 3-100ths per cent of arsenious acid prevents the germination of seeds and destroys the embryo plant.

For the purpose of throwing some light on this difficult problem of the influence of metallic oxides upon plant life, a series of experiments was carried out during last spring in the greenhouse of the Allegheny park, by the kind permission of the superintendent of the park, Mr. William Hamilton.

The object of these experiments was to determine, first, whether any injurious effects are produced upon plants by being grown in soil impregnated with certain metallic oxides; secondly, whether plants in a perfectly healthy state will absorb such oxides through their roots. In the early spring the greenhouse was filled with very young plants, in a vigorous condition of growth, which were being reared for the purpose of supplying the park in the summer. The plants selected were geraniums, coleas, ageratums, achyranthes, and pansies. This selection was made, not with reference to any special peculiarities of the plants, but for the reason that there were thousands of other plants of the same kind, and all equally advanced in growth, on the tables of the greenhouse, which afforded an opportunity for a close comparison of those grown upon poisoned soil with others grown under normal conditions.

The compounds used were the carbonates of zinc, copper, and lead, and as an arsenical compound, arsenate of lime. These compounds are almost absolutely insoluble in pure water.

The method of setting the plants was that commonly employed by gardeners in transplanting. Young plants, with their roots as nearly as possible intact, were placed in flower pots, and soil previously mixed with a weighed quantity of the metallic compound was poured in and pressed down around the roots. The first series included ageratums, which were grown in soil containing ½ per cent white-lead.

The second series consisted of geraniums, which were grown in soil containing ½ per cent carbonate of zinc.

The third series included achyranthes. The soil supplied to them contained ½ per cent carbonate of copper.

The fourth series were coleas, which were grown in soil containing ½ per cent arsenate of lime.

The fifth series included coleas, grown in soil containing ¼ per cent arsenate of lime.

The sixth series were pansies, grown in soil containing ½ per cent carbonate of zinc.

All these plants enjoyed the usual careful greenhouse nursing, and as regards temperature, moisture, and fertilit of the soil, the conditions were absolutely the same as in the case of the other plants, excepting the poisonous influence to which their roots were exposed.

The progress of each plant was watched and a record kept. On the 10th of June, eleven weeks after the commencement of the experiments, the plants were cut off above the roots, and those of each series subjected to analysis, with the following results:—

The ageratums, grown in leaden soil, matured and produced flowers as early as the most advanced of those

grown in ordinary soil. Their roots were very abundant and healthy, the only noticeable effect of the lead being that the leaves were of a yellowish hue. The analysis showed that lead had been absorbed in small quantities.

In the second series geraniums were reared in soil impregnated with carbonate of zinc. The plants were in every respect normal, bore flowers and produced abundant roots.

The analysis showed considerable quantities of zinc.

In the third series, achyranthes were grown in soil containing carbonate of copper. The effect of the copper was not visible in the plants at first, as they continued to grow rapidly, and were normal in colour. But in maturing, the bright leaves became darkened. It was found that the copper had killed the original roots, and totally arrested the development of new ones. The plants had apparently been nourished from the air alone. Very small quantities of copper were found in their ashes.

The most strongly marked results were produced in the case of the arsenic In the fourth series, coleas were grown in soil containing ½ per cent of arsenate of lime. The effects of the poison were visible in a few days, the plants languishing and producing but few leaves. In the course of two weeks all were dead.

In the fifth series, coleas were reared in soil containing ¼ per cent of arsenate of lime. The plants were feeble from the first, produced but few leaves, which were normal in colour. Although they endured with greatly diminished vitality, no increase in growth took place, and the stems were not strong enough to remain erect. In all cases the arsenic had totally destroyed the roots. Traces of arsenic were found in the analysis.

In the sixth series, pansies, grown in soil containing carbonate of zinc, produced abundance of roots and continued healthy. Analysis proved the presence of zinc in considerable quantities.

In view of conflicting statements of authorities, further experiments on a large scale, and extended to a wider range of plants, grown under varying conditions, would be needed to establish any general laws in regard to the absorption and influence of metallic poisons contained in soil upon vegetation. The discovery of these laws would probably lead to the discovery of methods for the prevention of such influences, so far as they are of a dangerous character.

From the experiments detailed above it seems safe to conclude, however:—

1. That healthy plants grown under favourable conditions may absorb through their roots small quantities of lead, zinc, copper, and arsenic.

2. That lead and zinc may enter the tissues in this way without causing any disturbance in the growth, nutrition, and functions of the plant.

3. That the compounds of copper and arsenic exert a distinctly poisonous influence, tending, when present in larger quantity, to check the formation of roots, and either killing the plant or so far reducing its vitality as to interfere with nutrition and growth.

In the case of the heavy metals, copper, zinc, arsenic, and lead, it seems to be probable that their oxides may under certain circumstances become deposited in the tissues of the plant. As to the manner in which this takes places, authorities differ.

It is supposed by Freytag and others, that plants absorb all soluble matters indiscriminately, through their numberless rootlets, that the absorption of poisonous metals causes no disturbance until a certain degree of concentration is reached, when the plant rapidly withers and dies; that plants are therefore spared the sufferings of chronic poisoning, but are very susceptible to acute poisoning, which is invariably fatal; while it is held by others that plants absorb only such elements as are essential and nutritious, refusing to take up what is poisonous or innutritious; metallic compounds found in the analyses are therefore to be traced to atmospheric deposit adhering externally.

The theory of Freytag seems to have the weight of facts in its favour, and if it is possible that crops may become charged in this way with poisonous elements of the soil, it becomes a matter of the highest importance that wherever there is danger of such impregnation the most efficient means be employed for its aversion; for soil once impregnated with copper, lead, and zinc, may year after year bear crops poisoned in the same manner.—*The Journal of the Franklin Institute.*

THE ORCHARD ALUM SPRING.*

By Dr. THRESH.

THIS spring, which appears to be a "descending" one, originates in a disused coal mine, near the summit of Axe Edge, the highest point in the Peak country. To get rid of this water a narrow tunnel has been bored through the side of the hill, just over the Staffordshire border, and about five miles from Buxton, and the water flows from the open end of this conduit into a tributary of the Dane. As the farm on the hillside is known as the Orchard (a most singular name for such a bleak and desolate spot), and the water has a strongly astringent taste, the spring is usually called the Orchard Alum Spring.

I am informed that years ago many members of the medical profession in the neighbouring towns and villages prescribed it frequently, but I do not think such is the case at the present time. The country people continue, however, to employ it, as a vermifuge, and as an external application for various skin diseases.

The water has a very decided red tint, varying in depth according to the character of the season. The sample analysed was collected after a period of continuous rain, and was not near so dark as it is usually seen, yet when placed in a wine-glass it looked like a pale sherry. Seen in large volumes in the deeper portions of the stream it has the colour of blood. It reddens litmus paper, but contains no free acid. When heated to about 150° F., it becomes quite opaque from the separation of a basic ferric sulphate, but if allowed to evaporate on the water-bath nearly to dryness, the basic salt re-dissolves and a yellow vitreous residue remains. When heated so as to cause the above salt to deposit, the supernatant fluid is quite colourless.

The mean of two concordant determinations of the specific gravity gave 1·00351 as compared with pure water at the same temperature, and each gallon was found to contain—

$Fe_2 3SO_4$	174·426	grains.
Fe_2O_3	6·275	,,
$Al_2 3SO_4$	72·908	,,
$MgSO_4$	21·055	,,
$CaSO_4$	14·381	,,
$FeSO_4$	1·596	,,
Na_2SO_4	0·537	,,
K_2SO_4	0·822	,,
$AlPO_4$	0·456	,,
KCl	0·282	,,
NH_4Cl	0·125	,,
KNO_3	0·170	,,
SiO_2..	5·776	,,
	298·809	,,

The results from which these quantities are calculated are tabulated at the end of the paper, and with regard thereto it may be remarked that in the first estimation of the phosphoric acid, the dried and weighed mixture of ferric and aluminic oxides and phosphates was fused with six times its weight of a mixture of 4 parts sodium car-

* Read at an Evening Meeting of the Pharmaceutical Society, Nov. 1.

bonate and 1 of silicic acid. The mass was exhausted with water containing a little ammonia carbonate, traces of silica removed by evaporation with acid, and the phosphoric acid precipitated with magnesia mixture. In the second determination the mixed oxides, &c., were dissolved in nitric acid, and the phosphoric acid removed by aid of ammonium molybdate.

Reference to the composition of the water, as given above, shows that the medicinal properties of the spring are due to the ferric and aluminic sulphates of which it contains so large a quantity. Undoubtedly it is of too powerful a character for internal use unless very considerably diluted, but even then, as a tonic, its value is impaired by the presence of the sulphate of aluminium. Its acid reaction, of course, is due to the presence of these salts, and the excess of ferric oxide explains the decomposition which takes place when the water is heated. It is somewhat singular, however, that when carefully evaporated, the basic salt first deposited re-dissolves, yielding a residue which can be diluted, forming a very nearly colourless solution. The acidulous and basylous radials in this latter case can scarcely be in the same state of combination as in the original water.

We have not far to look for the source of the more abundant constituents. The spring arises, or rather issues, from the hillside immediately above the upper surface of the millstone grit formation, which is here exposed and forms the bed of the rivulet into which the water flows. Overlying the sandstone is a layer of aluminous shale of a blue-grey colour, and doubtless by the action of the air and water this suffers such decomposition as to produce the soluble salts found in the spring. The exposed edges of this shale are encrusted with ferric oxide, and here and there after rain the water dripping off is seen to be distinctly coloured. Usually water passing through such a stratum contains a considerable amount of ferrous sulphate together with aluminic sulphate and a smaller or larger proportion of ferric salts, the formation of the first named being represented by the equation—

$$2FeS_2 + 7O_2 + 2H_2O = 2FeSO_4 + 2H_2SO_4.$$

The sulphuric acid then reacting upon the clay will form the aluminic sulphate. On the opposite side of the hill, the water flowing from a similar mine contains ferrous salt equivalent to 50 grains of crystallised ferrous sulphate to the gallon, with only a trace of ferric salt, and doubtless this is derived, by some such decomposition as the above equation represents, from the pyrites in the surrounding strata. To account for the formation of the ferric salt the oxidation must be carried further, the reaction being represented as follows:—

$$4FeS_2 + 15O_2 + 2H_2O = 2Fe_23SO_4 + 2H_2SO_4.$$

Further, by action of the ferric sulphate on the magnesium and calcium carbonates, with which doubtless the water comes in contact in some part of its course, the sulphates of magnesium and calcium would be formed together with ferric oxide and the basic ferric salt. An illustration of this decomposition is furnished by the stream into which the alum water flows. A few yards beyond the point where the iron water enters it, it receives another little tributary. The water in the latter appears to be rich in calcium carbonate, for where it falls into the larger stream the whole of the mixed waters become perfectly muddy, and for a considerable distance below the bed of the stream is thickly coated with an ochry deposit.

By way of conclusion it may be remarked that a water of this kind proves in a marked degree the futility of attempting to check the analytical results by comparison with the amount of solid residue left upon evaporation of a given quantity, whatever may be the temperature at which the residue is finally dried. The whole of the water could only be driven off in this case by heating to such a degree that the ferric sulphate began to decompose, and the residue then was so hygroscopic that an accurate weighing was impossible.

Table of amounts of products obtained during the analyses calculated as from 10,000 *parts of water.**

	Portion of residue soluble in water.	Portion insoluble in water.	Total.	Total estimation.	Mean.
SiO_2		0·825			0·825
$BaSO_4$ ..	67·188	2·334	69·522	69·406	69·464
AgCl.. ..	0·080			0·076	0·078
HNO_3 ..				0·015	0·015
CaO	0·449	0·391	0·840	0 853	0·846
$Mg_2P_2O_7$ (for magnesia estimation)	2·742			2·822	2·782
NaCl ..				0·063	0·063
KCl				0·159	0·159
NH_3.. ..				0·006	0·006
MN_3O_4 ..	Minute trace.				
FeO				0·108	0·108
$Mg_2P_2O_7$ (phosphates)	0·093			0·088	0·090
$Al_2O_3 + PO_4 + Fe_2O_3$	12·428	0·398	12·826	12·968	12·897
Fe_2O_3 ..				9·580	9·607
Al_2O_3 ..				3·204	3·213
Albumenoid NH_3				0·001	0·001

Pharmaceutical Journal, November 4, 1882.

NOTES ON WATER ANALYSIS.†

By REUBEN HAINES.

Within the past few years renewed efforts have been made to place the much troubled subject of water analysis in a more satisfactory condition. Among others may be mentioned the recent investigations under the direction of the National Board of Health of this country. Difficulties of an extraordinary character are experienced, inasmuch as the chemist is called upon not only to estimate quantitatively substances of the properties and constitution of which he knows little or nothing, and of the very existennce of which he may be doubtful, but also he is expected to state his opinion as to their physiological effects when taken within the human body. In the latter demand may be said to lie in the majority of cases the exclusive interest of his client. People usually do not care much about the figures in the analysis; they simply want to know authoritatively, with certainty, whether the water is wholesome, and if not what is the cause and how it can be remedied. To answer these questions an exact quantitative analysis is considered necessary.

These difficulties are made a hundredfold greater by the fact apparently well established that some of these substances, whatever they may be, whether living or dead, can produce manifest effects when present in exceedingly minute quantity. Add to this the fact that, owing to different methods of analysis being used and different views being held as to the significance of the several results of analysis, the most diverse opinions have occasionally been expressed in regard to the wholesomeness of the water supply of a city or town by chemists of established reputation. Unfortunately some of these opinions have been expressed with a positiveness unwarranted by the state of our knowledge.

Surely any well-directed and well intentioned effort to relieve this important subject of some of its difficulties is commendable. Chemists are therefore to congratulated, as being one of the steps toward this end, on the greater disposition to recognise the respective merits and demerits

* *Vide Journ. Chem. Soc.*, April, 1882.

† Read before the Chemical Section, Franklin Institute, Sept. 5, 1882.

of rival methods of research. The feeling is becoming more evident that no single method of analysis now used can with any probability tell the whole story, and also that chemical must of necessity be coupled with microscopical and biological studies in many sanitary water analyses. In other words, every ray of light gathered from all the various sources that can be thought likely to illuminate this confessedly obscure subject should be utilised in every important investigation. It is a matter of importance, therefore, that any method of analysis which is widely adopted should be worked in such a manner that it will give uniform and strictly comparable results in the hands of different but equally conscientious chemists. Any effort to elucidate causes of variation should therefore be welcomed, however trivial and unimportant they might at first appear. This must, therefore, be my apology in offering the present paper.

Wanklyn's ammonia method is very extensively used, but the descriptions of it and of the judgment to be placed on a given water, which are to be found in the five successive editions of his Manual of Water Analysis, are, on a number of points, in the opinion of some, by no means entirely satisfactory. Neither do the various scattered papers on this subject by other chemists agree very well among themselves or with Mr. Wanklyn's instructions. It thus appears evident that Mr. Wanklyn unfortunately has not described his method with sufficient detail on some important points so as to enable other chemists less experienced in water analyses to obtain strictly reliable results, or as nearly so as is attainable by his method. In its conception the method appears very simple and easy to follow, but the precautions found necessary by experience are numerous, and on these points Mr. Wanklyn allows his readers to rest too much on their own unaided judgment, or states his opinion in a brief, *ex-cathedra* manner not at all satisfactory to the thoughtful student when he finds an opposite opinion expressed by an equally accomplished chemist. This is particularly to be regretted where, unlike the analysis of a mineral ore or technical product, the judgment of the chemist based upon the analysis is of far greater importance than the analytical results themselves. In such cases the fullest explanations of the basis of the opinions expressed should be given by the author of the manual, especially in the later editions when the method is being extensively adopted. It is, therefore, a matter of regret that the last edition contains so little change from those preceding by way of suggestion, hint, or explanation, which ought reasonably to follow from more extensive use. It seems probable that to this deficiency may be traced many erroneous, and in some cases worthless, analyses that have been made, upon the results of which the question of sanitary improvements on a large scale were to be decided.

In view of all the points just considered, I offer the following description of the manner of working the method, not imagining, however, that it is the best that can be devised, but simply as one which I have found to give satisfactory results. I hope it may prove suggestive of improvements and may lead to a uniformity of practice. As compared with this the mere statement of results in a uniform manner is of comparatively insignificant importance, although also desirable.

For the details of the method, which are not included in this paper, I refer to Wanklyn's Manual.

On the Albumenoid Ammonia Method.

In working the ammonia process of Wanklyn it is advantageous to connect the retort and condenser by means of a short piece of wide rubber tubing. The retort, selected of commercial pint size, but capable of holding more than 1 litre, should have a rather narrow neck, which can easily be thrust within the tube of the Liebig condenser to the distance of five or six inches without the glass surfaces being in actual contact. If the retort neck is rather too slender slip a second short piece of rubber tubing up the neck and thrust the latter into the condenser until the two pieces of rubber overlap each other. The rubber should always be tied down with cord, both on the condenser and on the retort, because it expands and loosens its grip on the glass during the distillation. Before connecting them every part, including the rubber, is thoroughly washed with clean tap-water, and they are then put together.* The retort, if it is new, or if it has been used just previously for very bad waters, should in the first place be rinsed out with about 10 c.c. of concentrated sulphuric or hydrochloric acid. When the apparatus is once set up many analyses may often be made on successive days, or at longer intervals, without it becoming necessary to disconnect the parts. In this case, before pouring in the sample to be analysed, flush the whole apparatus with tap-water conveyed by rubber tubing to the tubulure of the retort, into which a short glass tube, bent at a sharp angle, is inserted so that the jet of water is thrown directly into the neck of the retort. Into the beak or smaller end, of the condenser a clean cork is inserted and the whole tube and retort neck filled with water. When the water begins to overflow into the body of the retort the cork plug is removed and the whole mass of water allowed to rush out. This flushing is repeated two or three times, and the outside of the beak of the condenser is also washed by pouring clean water over it. The water which has collected in the retort is removed by a glass syphon, which has been just previously well washed. At the conclusion of an analysis the permanganate liquid is removed by the syphon, introducing clean water, and syphoning it out until no longer coloured.†

In the case of very bad waters, however, a deposit of manganese oxide often forms on the bottom of the retort, which, if allowed to accumulate, may cause violent bumping, thereby endangering the retort and contaminating the distillates with permanganate. In such cases it is necessary to disconnect the apparatus and clean out the retort with a little hydrochloric acid, taking care to wash very thoroughly afterwards. The slight film of manganese oxide frequently forming high up on the sides of the retort may, however, be neglected as having no injurious influence. The prevention of this sudden bumping is sometimes a very troublesome matter. I find that it occasionally occurs with soft spring waters of first-class purity, and it cannot then be attributed to an accumulated deposit on the retort. A very pure spring water, which I have examined a number of times, has invariably bumped, often two or three times during a single distillation, with permanganate, and so badly as to foam up and flood the condenser without any warning or noise, even when the retort neck was inclined upward. It appeared rather to be owing to a sudden liberation of steam throughout the whole mass of liquid at once, but ignited fragments of pumice introduced into the retort did not check it. On the other hand, when an organic liquid, such as diluted milk, was introduced into the retort with this same spring water and permanganate, as in Wanklyn's method for estimating the albuminates in milk, the distillation, which before was very turbulent, now immediately became regular and tranquil, with no bumping, and small bubbles breaking on the surface instead of the large ones of the previous distillation to purify the water. On syphoning out the liquid after the operation was finished a considerable deposit of oxide, formed by the reduction of

* It may be proper to state that at the time of presenting this paper I had not read the articles on this subject which appeared during the early part of this year in the *Analyst*, in which a similar arrangement of the retort is recommended.

† It should be stated that the working details to be described may perhaps prove to be better adapted to the analysis of soft waters, or those waters the hardness of which is due to sulphates rather than carbonates. A number of the hard waters from the neighbourhood of Philadelphia, which I have analysed, are of this character. It is not likely, however, that calcium and magnesium carbonates would form any strongly adherent deposit on the bottom of the retort in a boiling liquid of comparatively high specific gravity, such as the permanganate liquid becomes. I have usually found that the deposited carbonates could be almost completely syphoned out by doing it while the liquid is still hot.

the permanganate, was found adhering to the bottom of the retort.

Several methods of avoiding this difficulty have been suggested in Wanklyn's Manual and in various papers in chemical journals. Some advise introducing into the retort recently ignited pieces of pumice or tobacco pipe, or else a judicious shaking or tapping of the retort during the distillation so as to produce a wavy motion in the liquid, or inclining the retort upward so that the liquid may not enter the condenser. I have tried all of these methods, but find the following plan decidedly preferable to any of them. I watch the retort very closely during the whole distillation when the trouble is likely to occur, and at the instant that the liquid is observed to foam up snatch away the Bunsen burner from below the retort, replacing it when the foam subsides. This may have to be repeated several times. In very troublesome cases it is well to keep the hand upon the burner ready to remove it instantly. Toward the latter end of the distillation spirting of the concentrating liquid is apt to occur. This may be checked by regulating the flame by a screw spring compressor on the rubber gas tubing and distilling more slowly. If a fourth or fifth portion of 50 c.c. has to be distilled over, the flame should be lowered to prevent the fracture of the retort, or else from 100 to 200 c.c. of perfectly pure distilled water should be added to the retort. The distillation should be continued until 50 c.c. of the distillate developes no colour with Nessler test on standing several minutes, or at least contains not more than 0·005 m.gm. NH_3. This can be ascertained by Nesslerising the third or fourth 50 c.c. distillate while the following one is distilling. It is sometimes necessary to estimate the ammonia in the fifth or even in the sixth 50 c.c. portion, but usually the fourth portion contains less than 0·005 m.gm. NH_3. Of course, the free ammonia must be known to be completely expelled before commencing the distillation with permanganate; hence, in highly ammoniacal waters it is best, after distilling off 200 c.c., to distill and Nesslerise a succeeding 50 c.c. before adding the permanganate to the retort.

In many cases the precautions above given against bumping will be found quite unnecessary, and other parts of the analysis, viz., the Nesslerising the free ammonia, and the estimation of the chlorine, may be attended to during the progress of the distilation. If the albumenoid ammonia distillates are Nesslerised in the reverse order, the third before the second and the second before the first, a tolerably accurate guess can be made at once as to the amounts of ammonia in each. In very many cases in my experience the first portion contains about twice the second and the second twice the third. We thus know at once whether it will be best to dilute the first distillate before adding the Nessler solution. Some waters, as for example those that are turbid with organic matter, or peaty waters, will not be likely to follow this rule, and some analysts have claimed that the manner in which the distillation progresses is a means of distinguishing vegetable from animal organic matter, or at least affords information which is an aid in forming a judgment of the quality of the water. It would seem best, therefore, to measure accurately each separate distillate and keep on permanent record the amount of ammonia which it contains.* If the water contains so much free ammonia as to give a decided colour with the Nessler test in 50 c.c. of the sample without distillation the free ammonia can be more accurately estimated by distilling off 200 c.c. in one portion, diluting with ammonia—free distilled wate, taking out an aliquot part, and diluting again, if necessary, to 50 c.c.; Nesslerise this and multiply by the proper factor. Some of these ammoniacal waters appear to yield four-fifths, or even five-sixths, of the total amount of the free ammonia in the first 50 c.c. distilling over, instead of three-fourths, which is usually the case as stated by Wanklyn. This variation is of no practical importance, however, since such a water would certainly be condemned by either method of calculation if it comes from a shallow well or spring.

In the distillation it is necessary to have a current of water through the condenser sufficiently rapid to avoid perceptible heating of the latter, except at the outlet. I prefer to use a 4-jet Bunsen burner, and operate on a half litre of the sample. I have obtained identical results when using quantities of half litre and full litre of the same water on the same day, or as nearly identical as is possible in these colorimetric estimations. My own limit of accuracy in colorimetric observation in matching the colours I have found to be 0·002 m.grm. of ammonia in amounts of more than 0·010 m.grm. in 50 c.c. of water. Hence, a plus or a minus error of this amount is liable to occur in every Nesslerising. I believe, however, that these errors, to some extent at least, neutralise each other, since several duplicate analyses can be made agreeing much more closely than would be the case if the errors were all in one direction. Moreover, the corresponding distillates in different duplicate analyses are often found to contain identical amounts of ammonia, which, of course, fortifies their accuracy, provided that the distillates are of equal volume. Although working on amounts of a full litre avoids the doubling of this error, there are counterbalancing disadvantages attending it. It is, of course, very necessary for the chemist to ascertain if he is afflicted in any degree with colour blindness. If he is colour blind only to a very insignificant extent, it may possibly be expressed quantitatively, and allowed for as a sort of "personal equation." But if this defect is very marked it is hardly necessary to say he ought to relinquish the practice of this method of water analysis, and perhaps all other methods necessitating colorimetric observation. This precaution is of some importance from the fact ascertained by statistics, that about one man in twenty is more or less colour-blind. Among women the percentage having this defect is much less. I find it is very difficult to estimate the colour when less than 0·005 m.grm. of ammonia is found in 50 c.c. of the distilled water; hence, amounts of less than this figure are neglected in adding up for the total amount. I do not think this error of omission can be avoided by distilling the albumenoid ammonia in one portion, returning this to the retort and re-distilling in separate portions of 50 c.c. each, as was suggested by Mr. Sidney Rich, for waters containing small amounts of albumenoid ammonia. Due allowance must, therefore, be made for these possible errors in the estimations of colours, when analyses of different samples of water are compared with each other, and a slight difference in results may indicate no real difference in the quality of the waters under examination.

It is important to have the alkaline permanganate solution guaranteed perfectly free from ammonia. This degree of purity I have been unable to obtain by following any of the directions for its preparation heretofore published. Dr. Tidy, in a paper on the methods of water analysis, read before the (London) Chemical Society, Dec. 5, 1878 (*Jour. Chem. Soc.*, vol. 35, p. 62), states that he believes "it to be practically impossible to prepare alkaline solutions of potassic permanganate absolutely free from ammonia. I have, myself," he says, "followed with the greatest precision the details given by Mr. Wanklyn for its preparation, and, moreover, have tried a large number of other means that have suggested themselves, such as fusing the potash before dissolving, and such like, without avail. Nor have I found any permanganate solution made by others which was entirely free from ammonia. Hence it has always been necessary to estimate the quantity of ammonia in the permanganate solution, and to deduct this from the total amount obtained in the actual experiment."

In the discussion of this lengthy and important paper, which was postponed to take place at a special meeting on Feb. 6, 1879, Mr. Wanklyn, toward the close, stated that "he had never had any difficulty in obtaining his alkaline permanganate free from ammonia, and he could not tell

* The author of the paper in the *Analyst* cited above recommends mixing all the albumenoid distillates, measuring out an aliquot part, and making but one Nesslerising. It might be well to compare the numerical accuracy of the two methods.

what results might be arrived at by using impure solutions of permanganate, and allowing for the impurity" (Chemical News, Feb. 14, 1879). This remark was elicited by a question in regard to some extraordinary discrepancies in the analysis of certain London waters, by two chemists, both of whom used the ammonia method. Mr. Wanklyn, however, appears not to have explained how he obtained a pure solution of permanganate.

(To be continued).

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, November 11th, 1882.

Prof. Clifton, President, in the Chair.

Prof. Rowland, of Baltimore, exhibited a number of his new concave gratings for giving a diffraction-spectrum. He explained the theory of their action. Gratings can be ruled on any surface if the lines are at a proper distance apart and of the proper form. The best surface, however, is a cylindrical or spherical one. The gratings are solid slabs of polished speculum metal ruled with lines equidistant by a special machine of Prof. Rowland's invention. An account of this machine will be published shortly. The number of lines per inch varied in the specimens shown from 5000 to 42,000, but higher numbers can be engraved by the cutting diamond. The author has designed an ingenious mechanical arrangement for keeping the photographic plates in focus. In this way photographs of great distinctness can be obtained. Prof. Rowland exhibited some 10 inches long, which showed the E line doubled, and the large B group very clearly. Lines are divided by this method which have never been divided before, and the work of photographing takes a mere fraction of the time formerly required. A photographic plate sensitive throughout its length is got by means of a mixture of eocene, iodised collodion, and bromised collodion. Prof. Rowland and Captain Abney, R.E., are at present engaged in preparing a new map of the whole spectrum with a focus of 18 feet.

In reply to Mr. Hilger, F.R.A.S., the author stated that if the metal is the true speculum metal, used by Lord Rosse it would stand the effects of climate he thought; but if too much copper were put in, it might not.

In reply to Mr. Warren de la Rue, Prof. Rowland said that 42,000 was the largest number of lines he had yet required to engrave on the metal.

Prof. Guthrie read a letter from Captain Abney, pointing out that Prof. Rowland's plates gave clearer spectra than any others; they were free from "ghosts," caused by periodicity in the ruling, and the speculum metal had no particular absorption.

Prof. Dewar, F.R.S., observed that Prof. Liveing and he had been engaged for three years past in preparing a map of the ultra-violet spectrum which would soon be published. He considered the concave gratings to make a new departure in the subject, and that they would have greatly facilitated the preparation of his map.

Mr. W. Brown then read a paper on the "*Conservation of Energy and Central Forces.*" He showed that the doctrine of the conservation of energy necessarily involved central forces, and could not be proved unless on the assumption of a system of central forces. This involved the hypothesis of Boscovich that matter consists of a collection of centres of force, and the author criticised the objections of Clerk-Maxwell, Tait, and others, to Boscovich's theory. The paper will appear in the *Transactions* of the Society.

Prof. S. P. Thompson read some "*Historical Notes on Physics*," in which he showed that the voltaic arc between carbon points was produced by a Mr. Etienne Gaspar Robertson (whose name indicates a Scotch origin), at Paris, in 1802. This reference is found in the *Journal de Paris* for that year. Laboratory note-books at the Royal Institution, however, are said to show that Davy experimented with the arc quite as early. The experiment usually attributed to Franklin of exhausting air from a vessel of water "off the boil," and causing it to boil afresh, is found in Boyle's "new experiments touching the spring of the air."

Prof. Thompson also exhibited an early Reis's telephone made by Phillip Reis, in 1851, at Frankfort, and designed to transmit speech. It was modelled on the human ear, one form of transmitter being a rudely carved wooden ear with a tympan, having a platinum wire behind hard pressed against a platinum tipped adjustible spring. Prof. Thompson showed by various proofs that words were actually sent by that and similar apparatus.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, November 6, 1882.

The Hon. Sir Wm. R. Grove, D.C.L., LL.D., F.R.S., Manager and Vice-President, in the Chair.

Captain W. de W. Abney, R.E., F.R.S., George Wightwick Rendel, M.I.C.E., were elected Members of the Royal Institution.

The special thanks of the Members were given to His Grace The Duke of Northumberland, for his valuable present of "Descriptive Catalogue of the Antiquities at Alnwick Castle, 1880;" and "Catalogue of Egyptian Antiquities at Alnwick Castle, 1880."

Two candidates for membership were proposed for election.

The Presents received since the last meeting were laid on the table, and the thanks of the members returned for the same.

NOTICES OF BOOKS.

The Magneto-electric and Dynamo-electric Machines, and the so-called Secondary Batteries, with particular reference to their Construction. (Die Magnetelektrischen und Dynamo-elektrischen Maschinen, und die sogenannten Secundär Batterien.) By Gustav Glaser De Cew. A. Hartleben: Vienna, Pest, and Leipzig.

The work before us forms the first volume of a series entitled "Elektrotechnische Bibliothek" (Electro-technical Library), which undertakes to treat in detail of the practical applications of electrical science. The author introduces his subject with a historical account of the gradual development of magneto-electric and dynamo-electric machines. He discusses in succession the phenomena of induction, the principle of the machine of Pixii, the commutator, Stoehrer's magneto-electric machine, the cylinder inductor of Siemens, Pacinotti's ring, the current in a ring inductor, the direct action of the fixed poles upon the spirals of the ring, the construction of Pacinotti's machine, Wilde's machine, the principle of dynamo-electric machines, and Ladd's machine with two cylinders. In the first chapter we find an account of machines which yield alternating currents, such as the Alliance, those of de Méritens and Holmes, Weston's machine for galvanoplastic work, Mohring and Baur's dynamo-electric machine, the alternating machines of Gramme, of Siemens, and the Brush machine. The second chapter is devoted to machines producing currents in one direction only. Under this head we find especial mention of the

Gramme ring, collector, and light machine, the current in the spirals of tripolar magnets, the machines of Fein, Schuckert, Heinrich, Fitzgerald, &c.

In Chapter III. the author enters upon an examination of the merits and defects of the various kinds of electric machines. He considers that those which produce alternating currents are preferable for electric lighting on the systems of Jablochkoff, Jamin, &c., and they are always preferable when the object in view is not so much an advantageous utilisation of the power applied, but rather an equable consumption of the carbon points in the electric lamps, and an avoidance of residual magnetism in the electromagnets of these lamps. Hence these machines in their improved form—*e.g.*, those of De Méritens—meet with a very wide application in lighthouses. On the other hand, if it is requisite to light up wide spaces, streets, or large halls, machines which produce continuous currents in one and the same direction are preferable. Such machines are likewise advantageous where it is desired to obtain the greatest possible effect from the machines, as they yield in the electric arc a result greater by about 35 per cent than do the alternating machines. They are also preferable for galvano-plastic and metallurgical purposes.

On comparing the magneto-electric and the dynamo-electric machines, the author pronounces the former more advantageous in their principles,—those especially whose inducing magnets are constituted by electromagnets.

As a formidable source of irregularities in the strength of the current of the dynamo-electric machines, we find reference to the changes which take place in the resistance of the exterior conduction. Thus, if the current is utilised for the production of electric light between two carbon points, every change in the luminous arc involves not merely an equal, but a proportionally increased, change in the strength of the current of the machine.

In the fourth chapter we have an account of arrangements for regulating the current, such as those of Siemens, Sawyer, and Maxim. Thence the author passes to the consideration of secondary batteries, such as those of Planté and Faure. The latter he considers will prove, under certain circumstances, of invaluable service, notwithstanding the loss of 40 per cent of electric power which they involve. Still their utility as portable accumulators is not so unlimited as it has been pronounced.

The fifth chapter is of a mathematical character. It deals with the physical laws which relate to the construction of electrical machines and their practical application.

In Chapter VI. the author gives special advice on the construction of the various parts of electric machines, such as the inducing magnets, the armatures, &c.

The seventh and eighth chapters discuss the application of the machines for the production of the electric light and for other purposes.

An appendix gives formulæ for the construction of electromagnets, and an account of the instruments useful for executing measurements in connection with electric machines. The work is provided with 54 illustrations, and with a table of the units employed in electrical measurements.

Arithmetical Chemistry, or Arithmetical Exercises for Chemical Students. By C. J. Woodward, B.Sc., Lecturer on Chemistry and Physics, Birmingham and Midland Institute. Part I., Elementary. London: Simpkin, Marshall, and Co. Birmingham: Cornish Brothers.

This little work proves—what the recent Presidential Address of Mr. J. A. Froude might lead the public to doubt—that the Birmingham and Midland Institute is still engaged in giving scientific instruction. Our readers will doubtless remember that Mr. Woodward some time back brought out a useful treatise under the title "Arithmetical Exercises for Chemical Students." The publication before us is a revised, or rather re-modelled, version of that work. The author has added to the examples an explanation of the scientific basis upon which the problems depend. We have already expressed the opinion that exercises of the class in question—first suggested, if we mistake not, by Professor R. Galloway, of Dublin,—are of great value in impressing upon the mind of the student what may be called the mathematical phase of chemistry, and we certainly see no reason for modifying our opinion. We find here exercises in the metric system of weights and measures, in specific gravity, on the relations of the density of a gas to its molecular weight, in chemical equations, in the calculation of formulæ from centesimal composition, &c.

As an appendix we find "a collection of 100 problems, mainly taken from the examination papers of the Science and Art Department and the University of London Matriculation." To these are subjoined their answers.

On the fly-leaf we notice the announcement of another work by the same author. It consists, we find, of the whole of the questions in Physics and Chemistry, given at the Matriculation Examinations of the University of London, from June, 1864, to January, 1882. This work, the author considers, "must be useful to a large circle of teachers and students." Mr. Woodward is right; such a work will be of especial interest to those enterprising gentlemen who "prepare" students for examinations of all kinds. These teachers will subject the questions to a most careful analysis by this means, and by a minute study of the predilections and the idiosyncrasies of each examiner they will calculate with approximate accuracy for what questions the pupil must be carefully prepared, and what, on the other hand, he can afford to ignore.

The Yorkshire College, Leeds. Calendar for the Ninth Session, 1882-83, and Prospectus of the Leeds School of Medicine.

This publication gives a full account of the Yorkshire College, its history, constitution, day and evening classes, associateship, scholarships, examinations, &c. The Chair of Chemistry is still ably filled by Prof. T. E. Thorpe, F.R.S., who gives lectures in organic and inorganic chemistry, besides conducting a course of practical laboratory work. Professor Green, F.G.S., conducts the classes for geology, mineralogy, and mining. Experimental physics is taught by Professor Rücker, assisted by Mr. C. Spurge. We are glad to perceive that students of this subject have the opportunity of going through a complete course of laboratory practice.

The department for dyeing and tissue-printing, endowed by the Clothworker's Company of the City of London, is conducted by Mr. J. J. Hummel, F.C.S. The syllabus of instruction is exceedingly full, and embraces not merely dyeing in the stricter sense of the word, but the manufacture of tinctorial preparations, their adulterations, valuation, &c. There is opportunity for actual work in the dye-house from 9 a.m. to 5 p.m. every day during the session. Students in the dyeing department are expected, at some period of their College course, to present themselves for the Examination in Dyeing of the City and Guilds of London Technical Institute.

It may perhaps not be deemed ungracious if we note as a singular fact that although the Yorkshire College was originally intended to be for the study of Science only,—witness its pristine name, the "Yorkshire College of Science,"—the Principal of the Institution and Chairman of the Academic Board is the Professor of Classical Literature and Philosophy.

The Leeds School of Medicine, now beginning its 52nd Session, is to a certain extent connected with the Yorkshire College, where its students attend the lectures of Prof. Thorpe in Chemistry, and of Prof. Miall in Botany, Comparative Anatomy, and Zoology.

The value and the influence of the Yorkshire College are making themselves widely felt, and that not merely in a technological point of view. We have no doubt that as

the Institution gains strength, such men as Profs. Thorpe, Rücker, Miall, and Greene, will endeavour to lead their pupils into the path of original research.

Synopsis of Chemistry, Inorganic and Organic: To assist Students preparing for Examinations. By T. W. Drinkwater, F.C.S. Edinburgh: Young J. Pentland. London: Hamilton, Adams, and Co.

Mr. Drinkwater begins his preface with the admission that "In these days of superabundance of chemical literature some apology is needed for introducing yet another chemical volume to public notice." It seems to us that some limitation is here needed. With good works on the philosophy of chemistry, and on many departments of chemical technology, we are by no means superabundantly provided. The excess is met with only in that very region which the author has selected, *i.e.*, in compendiums, manuals, synopses, handbooks, &c. The majority of these little works are compiled with the object, more or less distinctly expressed, of assisting students in preparing for examinations. Mr. Drinkwater tells us that certain portions of this book "have been for a considerable period (time ?) in circulation among the members of my classes, and have proved of great assistance in preparing for examination my students, many of whom *have not the time to collect and arrange scattered facts as presented in the Text-books.*" We call especial attention to the words we have italicised, as also to the following passage:—"It will, I hope, take the place of the Note-book in recalling the principal facts of the Science in the unsettled and troubled times which precede examination."

Having had the good fortune to grow up before the outbreak of the examination epidemic, we used to study with the humble and old-fashioned purpose of knowing. Consequently we cannot, from personal experience, judge of the wants of an intending examinee, and of what, in such "unsettled and troubled times," may prove most useful. But the above extracts border somewhat closely upon an avowal that the volume before us is written for "coaching" purposes. We hasten to add that by these comments we mean no disrepect to Mr. Drinkwater. He is the victim of a vicious system, and unless he conform to its dictates he must expect to suffer. The fault lies elsewhere.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 17, October 23, 1882.

Separation of Gallium.—Lecoq de Boisbaudran.—(See page p. 211.)

A Bed of Coal discovered in the Province of Algiers, and the Deposits of White Sand which Accompany it.—G. Pinard.—Coal has been discovered near Bon-Saada in Algeria. It is said to be equal in quality to the best French or English coals. The sand is of a quality fit for use in the glass manufacture.

Metallic Thorium.—L. F. Nilson.—The density of thorium as obtained by reducing the anhydrous chloride by means of sodium was found by Chydenius, 7·657 to 7·795. The author has obtained metallic thorium by heating sodium with the double anhydrous thorium potassium chloride, in presence of sodium chloride in an iron crucible. After treating the residue with water there remains a greyish, heavy, sparkling powder, which under the microscope appears to consist of very small crystals. Metallic thorium is brittle and almost infusible; the powder takes a metallic lustre under pressure, is permanent in the air at temperatures up to 120°, takes fire below a red heat either in air or oxygen, and burns with a dazzling lustre, leaving a residue of perfectly white thoria. If heated with chlorine, bromine, iodine, and sulphur, it combines with them with ignition. It is not attacked by water, cold or hot. Dilute sulphuric acid occasions the disengagement of hydrogen, especially if heated, but the metal is acted on very slowly. Concentrated sulphuric acid with the aid of heat attacks the metal very slightly, evolving sulphurous anhydride. Nitric acid, strong or weak, has no sensible action. Fuming hydrochloric acid and *aqua regia* attack thorium readily, but the alkalies are without action. The metal examined by the author behaves with the reagents in question the same as did the specimens obtained by Berzelius. The mean specific gravity of pure thorium is about 11·000. Hence it would seem that the metal obtained by Chydenius must have contained much foreign matter. The specific gravity of pure thoria is 10·2207 to 10·2198. The equivalent and the density being known, we may calculate the atomic volume. If we admit that the metal is equivalent to 4 atoms of hydrogen, we obtain the value 21·1. This number coincides with the atomic volumes of zirconium (21·7), cerium (21·1), lanthanum (22·6), and didymium (21·5). This analogy is certainly not due to chance; it rather confirms the opinion which I have put forward in connection with my researches on the selenites, on certain chloro-platinates and chloro-platinites, &c., that the elements of the rare earths form a series of quadrivalent metals.

Determination of the Atomic Weight of Thorium.—L. F. Nilson.—The mean of six determinations gave for the equivalent of the metal 58·11, and consequently for its atomic weight 232·43. The mean of another series of four determinations gave: equivalent, 58·09; atomic weight 232·3 (oxygen is assumed = 8, and sulphur = 16).

Benzylene, Ortho-toluidine, and Methyl-phenanthridine.—A. Etard.—Not suitable for useful abstraction.

Reduction of Nitrates in Arable Soil.—MM. Dehérain and Maquenne.—The authors find experimentally that soil loses the property of reducing nitrates when it has been heated for some hours to 110° to 120°. Soil submitted to the influence of vapours of chloroform also loses its power of reducing nitrates. Soils, however, which have been thus sterilised by heat, recover their reducing power if mixed with a small quantity of normal earth. Hence the authors trace an analogy between the phenomena of the formation of nitrates and those of their reduction. The latter result is determined by anærobic organisms.

Moniteur Scientifique, Quesneville. August, 1882.

Industrial Society of Mulhouse.—Session of the Chemical Committee, June 14, 1882.—M. Camille Kœchlin made the following communication on aniline-black:—Aniline-black if developed at a temperature higher than 70° is ungreenable, whatever be the dehydrogenising metallic salt, if this substance and the duration of the high temperature are sufficient. All aniline-black formed in the cold is greenable. Ungreenable aniline-black was discovered in 1865 by M. H. Cordillot, of the firm of Huguenin Schwartz. The composition of Cordillot has the merit of being free from salts of copper. His black is produced by steaming aniline chlorate and ferricyanide. The important problem of transforming greenable aniline-black into the ungreenable state was solved in 1876 by M. P. Jeanmaire (Kœchlin Frères) who found that ferric salts possessed this property in heat. The various processes for converting a greenable into an ungreenable black all hitherto require a heat which dehydrates our mordants. M. Lauth, in a patent of 1869,

recommends to finish the dyeing by a hot passage in salts of chrome, copper, iron, mercury, alone or associated with chlorates, ferrocyanides, or chromates, but as this is only for the purpose of giving a tone to the black, and as the question of permanence is passed over in silence, these instructions do not affect the priority of Jeanmaire's process. A demonstration of the action of heat is easy by Lauth's process, dyeing with manganic oxide in solution of aniline. On operating in the cold the black is greenable; at 50° it retains this property; from 50° to 60° there is a change, and from 75° to 100° the black is ungreenable. This black is then less bluish, the difference being most appreciable in the greys. When dyeing on Lauth's system with conversion of the manganic mordant the solutions of aniline quickly blacken, and soil any colours which may exist on the manganese brown. This inconvenience may be remedied by adding to the aniline a twentieth part of naphthylamine and operating with very dilute solutions—2 to 4 grms. of alkaloid in the state of sulphate per litre, along with 20 grms. of calcined starch. These blacks, if produced in the cold and afterwards steamed, do not turn green sensibly. Lauth's process, which offers a commodious means of assaying the alkaloids, will remain the most rational, prompt, and economical, and is least injurious to the vegetable fibre.

— —

Journal de Pharmacie et de Chimie.
Tome vi., September, 1882.

Influence of Gum Arabic in Certain Chemical Reactions.—MM. Jules Lefort and P. Thibault.—In dilute solutions gum hinders the precipitation of metallic sulphides. In concentrated solutions, or when the proportion of gum is small, there is precipitation more or less incomplete. The precipitation of the metallic oxides is also prevented whilst in presence of gum, quinine, cinchonine, morphine, strychnine, brucine, and veratrine are not precipitated by the usual reagents, ammonium phospho molybdate, potassium-mercury iodide, and tannin. The gum does not dissolve the various precipitates formed or prevent their formation, but merely holds them in suspension. These results have a certain physiological importance. Most inorganic fluids contain glutinous bodies, and it is hence possible to understand the simultaneous presence in a soluble state in the animal and vegetable cellules of compounds capable of acting chemically upon each other. In analytical operations gum and analogous bodies must be removed before certain determinations can be effected.

New Mono-chlorinised Camphor.—M. P. Cazeneuve.—Already noticed.

On a Point Relating to the Microscopic Examination of Urinary Sediments.—M. Yvan.—Sodium urate, when abundant, may mask uric acid, calcium oxalate, ferments, epithelial cells, &c. The author in such cases either dissolves away the sodium urate in water, when uric acid and calcium oxalate remain insoluble. Preferably he heats the deposit in a test-tube to 50° by means of the water-bath, and as soon as the sodium urate is dissolved throws the whole upon a small filter, whence the sediment may be transformed for examination.

General Survey of Electro-medical Apparatus.—Dr. Onimus.—A long and profusely illustrated paper not capable of useful abstraction.

Volumetric Determination of Potassa.—M. E. Burcker.—The author examines the two existing processes. In one of these the potassa is thrown down as cream of tartar by means of a solution of sodium bi-tartrate. The precipitate is then washed on the filter with a solution of potassium bi-tartrate saturated in the cold, in order to remove the excess of soda, then dissolved in hot water and determined alkalimetrically with normal soda. In the modification proposed by Marchand, after having prepared a standard solution of sodium bi-tartrate, each c.c. of which corresponds to 1 centigrm. of potassa, the potassa is precipitated by means of an excess of this solution, and the excess added is determined by means of a standard alkali. The author finds that the direct method is preferable, being not only more exact but more rapid. The presence of sodium and magnesium salts does not interfere, but calcium salts should be previously eliminated.

Mathematical and Experimental Researches on the Curves of Solubility in Water of the Varieties of Tartaric Acid.—M. E. Leidie.—The results of this investigation are given in the form of tables.

Detection and Determination of Lithia in the Waters of Vichy.—M. A. J. Mallay.—An abstract in which the methods used are omitted.

Distribution of Arsenic in the Organism in cases of Poisoning by Arsenical Compounds.—Prof. Ludwig.—Arsenic may be detected in the bones both in cases of acute and chronic poisoning. Contrary to the statement of Scolusuhboff the brain never contains more than a small proportion, whilst the liver and the kidneys contain a large proportion. The muscles contain little, but more than the brain.

Solubility of Potassium Bi-tartrate.—MM. Van Babo and C. Portele.—Water at 0° dissolves 0·37 per cent of bi-tartrate, and at 100° 6·102 per cent. The solubility increases gradually without any anomalies.

Physiological Action of Collidine.—MM. Marcus and Oechsner de Coninck.—Collidine paralyses the voluntary movements and acts upon the nerves of the cornea.

Poisonous Action of the Lupin.—M. Bellini.—This plant is frequently fatal to sheep, and exerts a similar deleterious action upon horses, goats, and dogs. The alkaloids present have not been sufficiently examined.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Manufacture of Pure Chemical Reagents.—Will any of your readers kindly inform me of the best text-books on the manufacture of pure chemical reagents for laboratory use?—A. C.

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MEETINGS FOR THE WEEK.

MONDAY, 20th.—Medical, 8.30.
TUESDAY, 21st.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
WEDNESDAY, 22nd.—Society of Arts, 8. "Ice Making and Refrigeration," by Dr. John Hopkinson, F.R.S.
THURSDAY, 23rd.—Royal, 4.30.
—— Philosophical Club, 6.30.
FRIDAY, 24th.—Quekett Club, 8.
SATURDAY, 25th.—Physical, 3. "On Liquid Slabs," by Dr. F. Guthrie. "On Rainbows formed by Reflected Light," by W. Ackroyd.

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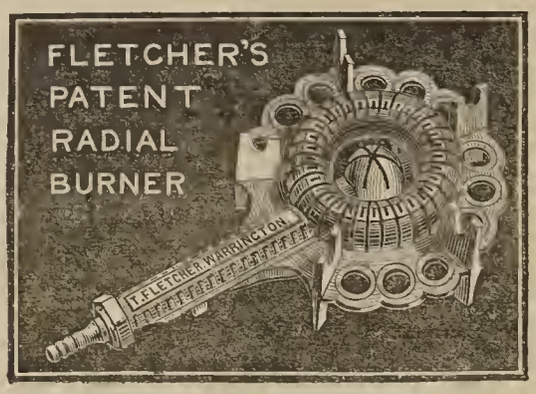

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THE CHEMICAL NEWS.

VOL. XLVI. No. 1200.

ON A

NEW METHOD OF MAKING A VOLUMETRIC SOLUTION FOR DETERMINING THE HARDNESS OF WATER.

By C. R. C. TICHBORNE, LL.D., F.I.C.,
Analyst to County Longford, &c.

IT is rather curious to observe that in spite of our constant familiarity with the determination of the hardness in waters, we have never been able to improve, or modify, to any extent the original process of Dr. Clarke, invented nearly half a century ago. We may go even further, and state that we have never been able to throw doubt upon his original investigations, and that they stand as he left them. Any so-called modifications are merely nominal, and have been made to suit the modern centesimal mode of expression. The most important proposals have been made in connection with the making of the soap solution and the standard calcium solution used for titration. A few of these modifications are, without doubt, improvements; but none of them touch in the slightest degree the principle of the process. Thus, in making the soap solution, Dr. Clarke used a soap made from animal fats (curd soap), and it has been respectively proposed to use a soft soap made from olive oil, lead soap (*emp. plumbi*), or a soda soap of olive oil (Castile soap). All these last proposals are undoubtedly better than the original curd soap, as proposed by Dr. Clarke, owing to the very simple fact that the fatty acids in the last three mainly consist of oleic acid, and that the oleates are less prone to separate in cold weather than the corresponding fatty bodies found in the curd soap.

As regards standard hard waters, I had adopted for some time the well-known modification of dissolving an equivalent quantity of powdered selenite. This process leaves nothing to be desired as regards the construction of a calcium solution. It is simple and gives most accurate results, providing there are no crystals of celestine in the selenite,—an experienced geologist will instantly detect them by his eye. It will be seen, however, further on, that the author proposes to dispense with the use of the calcium solution.

Having premised thus far, it might be asked, Why seek to change, or improve upon the process? Experience shows that the most troublesome part of the method consists in making the soap solution. Soaps are too indefinite in composition to admit of making a reliable solution by merely weighing out a given quantity and dissolving it in a proper quantity of spirit. Assuming that a soap of a definite fatty acid could be always obtained, we find the amount of water to differ so considerably as to render a titration necessary; a titration, too, which presents some considerable trouble.

My first idea was that if we took oleic acid and neutralised it with a standard solution of sodium hydrate, the latter base would represent the calcium salts, constituting hardness, equivalent for equivalent. I found, however, in practice that this is not quite so simple a matter as it would appear at first sight, but at the same time it is quite easy to construct a soap solution upon the basis of the soda hydrate consumed by the fatty acid.

The quantivalence of oleic acid may be, and has been, variously viewed. It is generally viewed as a mono-basic acid. As acid salts, however, are known, it may with equal propriety be classed as a bibasic acid; whilst, as will be seen further on, there is every reason to think that tetra-basic compounds of the alkalies exist.

5 c.c. of commercial oleic acid were dissolved in 50 c.c. of spirit of wine, and 1 drop of a 0·5 per cent solution of phenol-phthalein added. A volumetric solution of soda was then run in until a pink indication was obtained. After repeating this experiment two or three times the reaction was found to be not only well defined, but very constant. If litmus were used, not only is it difficult to determine the point of saturation, owing to the gradual transition of colours, but owing to the permanent dissociation of a trace of the oleates when in solution (to which the litmus is amenable), the reagent is not suitable to the experiments detailed. The 5 c.c. of oleic acid exactly worked off at 15·5 of the normal solution of soda of the British Pharmacopœia, which represents 0·62 grm., of sodium hydrate. Theory for the oleate having the formula $M'C_{18}H_{33}O_2$ would require 0·6 of hydrate of sodium, assuming the 5 c.c. of acid weigh 4·575 grms. Most samples of oleic acid found in commerce have a slightly lower gravity than this.

At this stage of the experiments a curious observation was made when water was substituted for the alcohol. The 15·5 of volumetric solution when added, as I have previously stated, gave a permanent liquid product of a faint pink tinge, showing that the point of neutrality had just been passed. A drop more of the volumetric solution developed a magenta colour, which was permanent as long as the solution was left at this point of saturation. A further equivalent of sodium hydrate was then run in (viz., 15·5 c.c.), when it gradually became colourless again, and at 7·75 c.c. began to pectise; the solution at this stage represented about the consistency of thick mucilage. When the full equivalent was present the solution became a solid jelly. The vessel in which it was obtained might be inverted with impunity. The pectised oleates seem to be permanent and definite compounds. From their behaviour when thrown into alcohol they appear to be hydrated compounds and are perfect colloids. If we push the action further, other compounds are formed which are much more soluble. There seems to be a wonderful analogy between silicic and oleic acid, and the technical application of silicates in soap making appears to have been one of those chance discoveries which are in advance of scientific knowledge. As I intend to reserve this part of the subject for a separate communication, I have only to consider on the present occasion the practical bearings of these observations.

The measures of the hardness in water are really the fatty acids, and it is almost immaterial whether we use the mono-basic or di-basic salt above mentioned. In these remarks we retain the old formula of oleic acid, but it is evident that the whole subject requires revision. We find by experiment that very little difference will be obtained, but that as the pectised salt seems to lather more freely, and as the solution seems more permanent, I prefer it.* We, however, always depend upon the sharp reaction obtained on adding the soda until the pink solution is developed with phenol-phthalein. This point always represents the proportion of NaHO as equalling pure $C_{18}H_{34}O_2$.

The following is the process:—

As already mentioned, 5 c.c. of oleic acid are measured with a pipette and 50 c.c. spirit added to it in a beaker; 2 drops of phenol-phthalein solution are also added, and immediately a volumetric solution of soda—

$$\left(\frac{NaHO}{1000} -\right)$$

is run in until a pink indication is produced. This must be done accurately, as the success of the process depends upon this measurement. If the gelatinous salt is required, another quantity of soda is then run in. The oleate of soda is then made up to the required measure by the

* This remark is not strictly true. I have found specimens of some oleic acids which do not work well, and do not readily pectise, and wherever there is any doubt about the results it is safer to merely add the exact proportion to neutralise the acid, as indicated.

addition of a mixture of equal parts of rectified spirit and distilled water. Each 15·5 c.c. of soda used in the first saturation equals 820 c.c. of volumetric solution of soap. Thus—

$$\frac{n \times 820}{15{\cdot}5} = x$$

n being the number of c.c. of soda solution which the oleic acid works off at, it is to be made up x. Such a solution makes a lather exactly on the original scale of Clarke, and it becomes unnecessary to titrate such a solution against a calcium solution, the soda solution being quite as definite and reliable as a calcium solution. Again, although different oleic acids might differ in purity, such a condition of things introduces no error; as the volumetric soap solution is made up on the saturating power of the acid employed, this alone determines the strength. Oleic acid obtained from the candle manufacturers, and a pure sample from Messrs. Hopkin and Williams, gave me exactly the same results in this respect, although they differed very much in their precipising properties. The 15·5 c.c. of soda required to saturate 5 c.c. of acid always neutralised in my experiments; but I am not prepared to say that this would be generally the case, and it is difficult to make in different hands a pipette always delivering separately the same amount of an oily fluid like oleic acid, therefore I proceed on the above basis of calculation.

The above process gives a solution, 32 c.c. of which when operating on 100 c.c. of water represent 16° of hardness per gallon by Clarke's scale.

The advantages claimed are that the soap solution may be made in five minutes,—requires no titration against a standard water,—and is more permanent than those made from ordinary soaps.

ESTIMATION OF SULPHUR IN PIG-IRON.

By H. ROCHOLL.

In the description of his new process for estimating sulphur in iron and steel by means of hydrogen peroxide (Chemical News, vol. xlvi., p. 199), Mr. G. Craig incidentally states, and apparently proves by experiments, that the residue left on dissolving pig-iron in strong hydrochloric acid be free from S, even should the metal under trial contain considerable quantities of copper. As according to this statement—generally and particularly in reference to the latter class of pig-iron—the information of the best analytical handbooks and the results of several previous contributors to this journal are incorrect, and certain troublesome precautions, or corrections, of analysts seem unnecessary, I think it ought not to pass without criticism.

Mr. Craig's proofs would indeed be surprising to those who have paid some attention to this subject, had he not duly given his method of examining the residue, viz., oxidation with $KClO_3$, evaporation to dryness, filtering, and mixing the filtrate with $BaCl_2$ solution. The presence of such large quantities of KCl and Fe_2Cl_3 would certainly prevent the precipitation of the small quantity of sulphur present, as even is proved by the author's intended check-experiment for the cupriferous pig. Here he obtains—in accordance with general experience—less sulphur when oxidising the whole of the metal with $KClO_3$ and HCl than what is evolved, on solution in HCl, in the gaseous form alone.

I would not, in the presence of ample evidence in respect of ordinary pig-iron, deem it necessary to give further data which disagree with Mr. Craig's conclusion, as, indeed, the difference in this case is insignificant, had I not found, on referring to some former experiments in this direction, some results which I think are worth recording: in some cases I obtained more than half of the S contained in cupriferous iron from the residue. The samples (10 grms. each) were in the usual way dissolved in HCl (50 c.c.), the hydrogen being passed through a five-bulb tube containing a solution of $AgNO_3$ in weak ammonia. The Ag_2S was separated and oxidised by Br water, the mixture filtered, and the filtrate precipitated by $BaCl_2$, when a portion of the sulphur (A) was obtained. The residue in the flask was likewise filtered, the solid portion (SiO_2,C, &c.) washed into a basin, evaporated, and then successively treated with HNO_3 and HCl, dried, re-dissolved, and filtered. From this filtrate in all cases a second precipitate was obtained by addition of $BaCl_2$, representing a second portion of sulphur (B). Finally the filtrate from the carbonaceous residue was diluted and mixed with $BaCl_2$ solution, when in no case, after several days standing, was a precipitate obtained.

	Copper.	Total Sulphur. P.c. of Pig.	Sulphur A evolved as H_2S. P.c. of Pig.	Sulphur B contained in Carbonaceous Residue. P.c. of Pig.	Sulphur B P.c. total Sulphur.
1. Cleveland pig-iron—	none	0·075	0·069	0·006	8
2. Ordinary Bessemer pig—	0·02 (about)	0·045	0·041	0·004	9
3. Ditto	0·02 (about)	0·026	0·021	0·005	19
4. Cupriferous ditto—	0·20	0·065	0·050	0·015	23
5. Ditto	0·23	0·017	0·011	0·006	35
6. Ditto	0·26	0·061	0·029	0·032	52
7. Ditto	0·26	0·064	0·027	0·037	58
8. Ditto	0·26	0·026	0·009	0·017	65
9. Ditto	0·27	0·041	0·026	0·015	36
10. Ditto	1·09	0·071	0·046	0·025	35

The first three analyses, representing ordinary pig-iron, are only a few of many others giving similar results, sulphur B varying from 0·004 to 0·007 per cent: I think an allowance of 0·004 per cent might fairly be made as an addition to the S, obtained by whatever method from the gaseous current. For cupriferous iron, however, a separate treatment of the residue is indispensable; the quantity of sulphur contained in it seems to depend as well on the total percentage of this element as on the quantity of copper present.

Clarence Iron Works, Nov. 13, 1882.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London, for the Month ending October 31st, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Right Honourable the President of the Local Government Board.

November 1st, 1882.

Sir,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the month of October, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily from Oct. 1st to Oct. 31st inclusive. The purity of the water in respect of

organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, one was "slightly turbid," and six were recorded as "very slightly turbid." The remainder were well filtered, clear, and bright.

Of the 26 samples from the mains of the Grand Junction Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, one was "slightly turbid" and five "very slightly turbid." The remainder were well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

During the latter part of the month, the condition of some of the samples of water examined was unsatisfactory in respect to their colour, turbidity, and proportion of organic matter. Having regard, however, to the exceptionally flooded state of the river, and its occurrence at a period of exceptionally high tides, the condition of the water supply as a whole, though comparing disadvantageously with that prevailing during the summer and early autumn, is scarcely open to unfavourable comment. Thus, putting aside the New River Company's water, as being largely contributed to by wells, and confining attention to the case of the East London Company, drawing its supply from the Thames and the Lea, and to the case of the Chelsea, West Middlesex, and Grand Junction Companies, drawing their supply from the Thames—in one sample only out of fifteen was the proportion of organic matter at all excessive, in seven samples only out of 104 was there any tinge of colour noticeable on careful inspection of the water in a tumbler or decanter, while in not one sample out of the 104 was there found any recognisable turbidity or freedom from brightness. Out of the total 182 samples of water examined, two only were recorded as "slightly turbid," and eleven as "very slightly turbid." In fourteen of the 182 samples, a slight but distinct brownish colour was perceptible, which—being in excess of the faint tints either not appreciable or scarcely appreciable on mere inspection, which alone come within the limits of measurement by the colour-meter—is in these instances left unrecorded numerically in Table II.

We have the honour to remain, Sir,
Your obedient Servants,

William Crookes,
William Odling,
C. Meymott Tidy.

Chemical and Physiological Researches on Certain Animal Fluids.—J. Mourson and F. Schlagdenhauffen.—The liquids examined were those of sea-urchins, of hydatic cysts, and of Cysticerci, and the amniotic fluid. In each case the presence of a ptomaine was detected.—*Comptes Rendus.*

NOTES ON WATER ANALYSIS.*

By REUBEN HAINES.

(Concluded from p. 230).

I have found it possible to prepare the permanganate solution so pure that when a litre of it is distilled *by itself in an undiluted condition* it will yield in the first 50 c.c. distillate, not more than 0·005 m.grm. of ammonia. To obtain it in this condition, I dissolve the required amounts of caustic potash (white sticks), and of permanganate in separate portions of ordinary distilled water; then mix, and dilute further to about 1500 c.c., and boil down rapidly in a capacious flask over a Bunsen burner to about 500 c.c.; then dilute again to about 1200 c.c. with ordinary distilled water, and boil again, as before, to about 900 c.c.; when cool make up the litre mark with water which has been re-distilled with alkaline permanganate till free from all traces of ammonia and organic matter. I have secured the same result by diluting in the first place to more than 2 litres with ordinary distilled water, and rapidly boiling down to about 900 c.c. and then at once making up when cool to the litre mark in the manner described. If I used ordinary Schuylkill river water for making the solution I found it was practically impossible to get it free from ammonia, nearly equal amounts continually coming over in the protracted distillation. In laboratories where the water supply is limited the flask need not be connected with the Liebig condenser until the boiling is nearly completed. This attachment is conveniently made by means of a large glass tube, bent at a right angle, and fitted to the flask and to the condenser by two pieces of wide rubber tubing, in such manner that it is only very slightly exposed to the action of the steam. It is scarcely necessary to add that it should be very thoroughly washed just before being attached. If, on testing the distillate, more than 0·005 m.grm. of ammonia is found the solution in the flask must be boiled longer or distilled water added and boiled down again as before. Care should be taken not to concentrate the solution too far, as it may thus suffer decomposition, and pass over into the green manganate with evolution of oxygen. This accident occurred twice with the present writer. This fact was also noticed by Mr. Wanklyn, as stated in the *Philosophical Magazine* for Feb., 1879. He says that "at temperatures very little above 100° C. a mixture of pure K_2MnO_4 and KHO evolves oxygen gas." In the concentrated liquid the boiling-point rises, of course, in proportion to the degree of concentration. "The gas is evolved very freely at temperatures even below 140° C., and the numerical results accord very well with the equation $2(KMnO_4) + 2(KHO) = 2(K_2MNO_4) + H_2O + O$. Hence the permanganate loses one-fifth of its active oxygen and becomes manganate of potash." I have also found that if the requisite quantities of permanganate and of caustic potash are dissolved in separate portions of water of somewhat more than one-half litre each, and a part of the permanganate is then poured into the potash solution while quite warm, the permanganate is in a few minutes completely reduced to the green manganate. It seems, therefore, that the mixing should always be done in the reverse manner and when the solutions are cold; that is to say, the potash solution sufficiently diluted should be gradually added to a dilute solution of permanganate.

In boiling the mixed solutions the appearance of numerous small bubbles over the surface of the concentrated liquor will be found to indicate that the solution is losing oxygen.

With the solution made in the manner described I have found some shallow wells so pure as to yield only 0·026 m.grm. per litre (or parts per million) total albumenoid ammonia, without correction, and including in the calculation the 0·005 yielded by the last distillate which gave

* Read before the Chemical Section, Franklin Institute, Sept. 5, 1882.

the slightest colour by the Nessler solution. Obviously no correction was admissible in such cases.

I believe, with Mr. Wanklyn, that it is unsafe to use an impure solution of permanganate, and make a correction for that impurity. Some time ago when using a solution of much less purity than the one described, I found several instances where, in distilling off the albumenoid ammonia from spring waters of the very purest character, the total amount of this ammonia obtained was less than the amount of correction which was to have been made for the ammonia in the 50 c.c of permanganate used in the analysis. In other words part of the ammonia had disappeared or was not developed in the diluted permanganate in the retort.

The Nessler solution I have found to be more satisfactorily prepared according to the directions of Dr. Frankland than according to those of Mr. Wanklyn. Particular care should be taken to render it sufficiently sensitive by a little addition of mercuric chloride solution. In Nesslerising 50 c.c. containing 0·040 m.grm. ammonia, the full colour ought to be developed almost immediately, and no change in intensity ought to be perceptible after half a minute has elapsed. In solutions containing less ammonia the colour is developed more slowly, but with even so little as 0·005 m.grm. the colour ought to be fully developed in less than two minutes. The whole estimation should be concluded as soon as possible for several reasons, one of which is that occasionally a turbidity will occur in the Nesslerised distillates in about ten or fifteen minutes, or a bright red precipitate will sometimes be found at the bottom of the glass when exposed to bright light, both of which occurrences are altogether fatal to any accuracy. The rapidity of development of the full colour produced by the Nessler solution is believed to be wholly dependent upon the degree of sensitiveness imparted by additional mercuric chloride to the Nessler solution. My experience in the rate of this development differs from the author of the articles in the *Analyst* cited near the beginning of this paper, and leads me to suppose that his solution was not made as sensible as may be possible.

The storage bottles of the Nessler solution should be kept as full as possible, the stoppers of which may be coated with paraffin, and a smaller bottle should be kept for immediate use. For this purpose I prefer to use a 2 oz. wide-mouthed, glass stoppered bottle, the stopper of which has never become tight, although it is not paraffined, which is, I think, an advantage in a bottle which is so constantly opened. This stopper is always replaced immediately after taking out the 2 c.c. by the pipette for each Nesslerising, as the solution should be exposed as little as possible to the atmosphere of the laboratory. By using the volume pipette with proper care the flocculent sediment which gradually forms at the bottom of the bottle produces little or no inconvenience to the operator, and only a very little of the solution need be thrown away at the last. The pipette for the Nessler solution serves also as a stirrer, and should always be washed immediately before and after each Nesslerising. This can be conveniently done by plunging the stirrer each time into a larger and firmly standing cylinder containing water which is fairly free from ammonia. If river water does not give the faintest colour with the Nessler test when not distilled it is sufficiently pure for this purpose. This water must of course be changed after a few testings. To make sure that everything is going on right it is well to have a blank Nesslerising cylinder handy containing water free from ammonia. By experience one can guess quite closely at the amount of ammonia present immediately after dropping in the Nessler solution, and it is not necessary to wait for the full development of the colour before making up the comparison cylinder. Hence, all the distillates and comparison cylinders can be Nesslerised in rapid succession. Since it is only occasionally that the experienced analyst finds it necessary to make up anew a second comparison cylinder of a different strength, the whole series of Nessler tests can often be completed within a very few minutes if all the apparatus required is ready for use at his elbow.

I have dwelt particularly on this point because some chemists appear to have been dissatisfied with the slowness and tediousness they have experienced in this operation, and on this account have been led to devise various methods and appliances for shortening it. Thus, some have used comparison tubes containing standard caramel solutions, either simple or those brought to the proper tint by the addition of colours like aniline red, &c. Otto Hehner devised a cylinder, graduated on the side and with a glass tap at the base, and estimated the amount of ammonia by the height of the column of liquid when the tints were equalised. Prof. A. R. Leeds has devised an expensive apparatus carrying two glass reflectors, between which the Nesslerised cylinders are placed, and the colours estimated in comparison with light passing through a prism containing a solution of caramel and aniline red. Although I have never used Leeds's apparatus, I think I can endorse the opinion I have seen somewhere expressed by an English chemist that all of these supposed aids will prove only to be hindrances to the experienced worker, and their proper management consumes more time than the original unaided method. It has some years ago also been shown that it is frequently impossible to secure the proper tint by caramel solution, and a mixture of caramel with such colours as aniline will be apt to change in a short time on exposure to light. I have tried the simple caramel solution, and as it has been the experience of other chemists, I have been compelled to abandon it. I have no doubt, however, that for such colorimetric estimations as Eggertz's method for carbon in steel Leeds's apparatus will prove a useful aid.

In regard to the time consumed in Nesslerising it will be understood that the purer the water under examination the more rapid are the testings; for with impure waters the distillates must be measured, diluted, and an aliquot part taken for the Nesslerising, which latter may have to be repeated several times before a convenient colour is produced. It is best not to have the colour too deep, nor should it be very faint. It is best not to attempt to estimate accurately colours deeper than that produced by 0·06 m.grm. of ammonia in 0·50 c.c. of water.

Notwithstanding Mr. Wanklyn's assertion to the contrary I believe perceptible ammoniacal vapours in the laboratory are decidedly objectionable, and therefore other analyses involving the use or evolution of ammonia or ammoniacal salts should not be permitted in the same room at the time the water analysis is made.

It is stated that the standard solution of ammonium chloride should never be run into the comparison cylinder *after* the Nessler test has been added, because a turbidity is thereby produced which spoils the colour estimation. While this is generally true for the addition of more than 1 c.c. of Wanklyn's ammonic chloride solution, I find that if the comparison test already made is not strong enough it may often be enforced by a few tenths of 1 c.c. of the NH_4Cl solution without producing any turbidity at all. Care should be taken, however, to stir very thoroughly with the pipette, or the colour may not increase perceptibly. Sometimes a peculiar turbidity will occur, however, on the slightest after-addition of NH_4Cl. Conversely, when the comparison test has been made a little too strong, a few tenths of 1 c.c. of NH_4Cl solution may be added to the cylinder containing the distillate, so as to make the colours exactly similar, and the amount of this addition is deducted from the amount of NH_3 found in the comparison tube. Greater care must be taken in this case, however, to avoid producing a turbidity, since the distillate cannot be replaced without repeating the whole analysis. This method of working economises both time and the amount of Nessler solution used in each analysis.

For the process of Nesslerising I find it convenient to use cylinders made by being blown from perfectly colourless test-tube glass, free from lead, care being taken that all the set of tubes are of the same diameter (or rather

capacity) and that they have good flat or slightly depressed bottoms so as to stand well unsupported. I prefer them to be of such size that 50 c.c. of liquid make a column about five inches in height, the tube itself being 15 centimetres in height and 22 or 23 millimetres in diameter. Three dozen of these cost me at the rate of seven cents a piece, and they are all very nearly of the same capacity with only two or three exceptions. A moulded base is very unsatisfactory.

The colour is best determined by looking perpendicularly down through the cylinder placed on a white porcelain tile, checking by raising the cylinder vertically an inch or two and observing again, or placing a smaller piece of tile at an angle of 45° beneath it, and also by holding the two cylinders side by side, flat against a white tile held vertically and opposite to the light. The Nesslerising should be done close to a window, for which perhaps a northern exposure is best, although this may not be important. I do not at all like Dr. Frankland's method of observing the colour of the meniscus by viewing it from above at an angle of 60°. Perhaps I should call this Prof. Miller's method, it being first suggested, I think, by him.

In point of economy of time, a burette holding 15 or 20 c.c. is preferable to a pipette for the delivery of the NH_4Cl solution. It may be of the ordinary Mohr pattern, a glass stop-cock being both unnecessary and troublesome.

In several cases in my experience the distillates containing the free ammonia had a peculiar odour. In one instance where the free ammonia was very large the distillate possessed what may be described as an "earthy" odour. In this case the albumenoid ammonia was remarkably small in amount. Tidy's permanganate method also showed an extremely small amount of oxidisable organic matter. To this case I shall have occasion to refer at a future time.

In another case of the water of a terribly polluted well, situated in the basement of a residence, on distilling with sodic carbonate, a strong disagreeable odour was noticed in the free ammonia distillate. This odour was similar to, but more intense than, the odour which the water itself possessed on being warmed. The free ammonia was 2·860 parts, and the albumenoid 0·512 part per million. The chlorine nitrates and total solids were all very low in amount. Sewage contamination was therefore improbable. The colour of dilute permanganate was, however, discharged rather rapidly. The water had an opalescent, or whitish, appearance in a flask, and there was a large amount of floating sediment of a fungoid character of very peculiar appearance as shown under the microscope. Some of these masses were groups of regularly distributed white opaque spheroids, while one resembled nothing better than a fragment of the most delicate white floss of fine filaments mashed together in a dense white mass nearly as broad as long. I can find no illustration of microscopic fungi at all closely resembling these substances. The special point to be considered just now is the odour occurring in the free ammonia distillate. It seems very probable that this was due to organic matter which volatilised unchanged on boiling with sodium carbonate, and although condensed with the free ammonia was not estimated as ammonia, and was consequently lost in the analysis. This appeared to me to be the explanation at the time of the analysis, October, 1880. It did not, however, occur to me at the time to repeat the distillation with alkaline permanganate alone for the total ammonia, as suggested by Prof. Remsen, of Johns Hopkins University, and also lately by Mr. Marsh, of Princeton College, in a paper in the *American Chemical Journal*, vol. 4, No. 3. The authors have shown that there is frequently a considerable discrepancy between the added free and albumenoid ammonia determined separately and the total ammonia developed by distilling with alkaline permanganate alone. The latter being always in excess in these cases, seems to indicate a frequently occurring loss of volatile organic matter in the ordinary distillation for the free ammonia. Hence, it would appear advisable always to repeat the distillation in this manner so as to check the results.

On July 17th of this year I collected myself a sample of water from the fore-bay of the Fairmount Water Works at a point under the stone bridge, and collected at arm's length below the surface of the water. The results of analysis were as follows:—

		M.grm. per litre.
Free ammonia	½ litre used	0·150
Albumenoid ammonia..		0·110
		0·260
Total ammonia by permanganate,	¼ litre used	0·264
Difference for volatile matter		0·004

This difference is, however, clearly within the limits of error of Nesslerising, and can therefore be rejected, and it is safe to assume that there was no volatile organic matter present in this sample of Schuylkill river water. It would have been better to have used at least a half litre for the total ammonia, but the amount of the sample collected did not admit of it, since the rest was used for the estimation of the oxygen required to oxidise the organic matter by Wanklyn's "moist combustion" method, as described in the fifth edition of his Manual. This gave the oxygen required by moist combustion to be 3·75 m.grms. per litre. This oxygen required for the Schuylkill water has been found to vary at different times from 2·75 to 3·75 m.grms. per litre.

The sample was collected about 10 o'clock a.m., a couple of hours after the fore-bay had been raked free from the grass and rubbish, as is done every morning. The water was not flowing over the dam; therefore, the analysis represents pretty fairly the average condition of the river at Fairmount on that day. A sample collected at the same time at the entrance to the forc-bay gave very nearly the same results.

At the time of this analysis the thorough dredging and cleaning of the fore-bay of Fairmount Works, as recently determined upon by the City Councils, had not yet been commenced.

It may perhaps be shown by future investigation that the differences in the ammonia supposed to be due to volatile organic matter may more frequently occur in the analyses of well waters than of river waters.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, November 16, 1882.

Prof. J. DEWAR, F.R.S., Vice-President, in the Chair.

IT was announced that a ballot for the election of Fellows would take place at the next meeting (December 7). The following certificates were read for the first time:—J. Brock, A. M. Chance, H. C. Foote, W. Fox, J. A. M. Fallon, F. Gothard, Joowansinghji, R. B. Lee, T. Turner, J. E. Tuit. During the evening a ballot was held, and the Scrutators, Dr. Japp and Mr. J. M. Thomson, declared the following to be duly elected Fellows:—J. Ferrier, T. Hughes, J. Hodgkin, F. Jordan, G. Jarmay, W. C. Nicholson, H. H. Robinson, L. Reid, J. E. Stead, G. H. Sharpe, P. G. Sanford, E. S. Spalding, C. J. Waterfall.

Mr. WARINGTON then read a paper entitled "*Contributions to the Chemistry of Tartaric and Citric Acids*," by the late BEAUMONT J. GROSJEAN. Mr. Warington said that for five years, 1870-75, he had worked in the laboratory at Millwall with the author of this paper, who had

since then been the sole chemist till his death, in June, 1882. Mr. Warington had, with the consent of Sir J. B. Lawes, compiled from the laboratory note-books of the late author an abstract of his numerous unpublished investigations :—

1. "*On the Different Rates of Loss of Different Specimens of Citric Acid in Dry Air.*"—Three specimens of different samples of citric acid were powdered and placed in two desiccators over fresh oil of vitriol on April 21, 1880. On May 6, one specimen had lost 0·68 per cent ; the second, 6·25 per cent ; the third, 8·55 per cent. On May 15 the first had lost 1·75 per cent ; the second, 8·55 per cent ; and on June 21, the first specimen had lost 8·47 per cent. The theoretical amount of moisture present was 8·57 per cent.

2. "*Determination of Citric Acid in Lemon and other Juices.*" The method used by precipitation with $CaCl_2$, &c., has already been described, *Chem. Soc. Journ.*, 1875, 931. It appears that the precipitable acid in commercial concentrated lemon juice is, on the average, very nearly equal in quantity to the free acid present. Thus, in 65 analyses, representing 895 pipes, the precipitated acid averages 99·2 per cent of the free acid ; some exceptional samples gave numbers from 85·8 per cent to 103·6 per cent. In bergamot juice the average number from 90 pipes was 98·4 per cent ; in lime juice, 91 to 92 per cent ; in orange juice, about 68·5 per cent of the free acid was found to be precipitable. Thus, while the determination of the free acid gives trustworthy results with lemon juice, it furnishes with lime and orange juice a very unsafe guide to the quantity of citric acid present.

3. "*Influence of Heat on Solutions of Tartaric Acid.*"—40 grms. of tartaric acid were dissolved in water and concentrated till a crust formed. The acidity was now reduced to 97·9 per cent of the original acid, while the ortho-tartaric acid, precipitated by potassium citrate, was only 74·6 per cent. On diluting and boiling for two hours the solution gave 99·9 per cent free acidity, and 99·9 per cent ortho-tartaric acid. The meta-tartaric acid formed as above is also slowly re-converted into ortho-tartaric acid by standing in dilute solutions at the ordinary temperature. Thus the percentage of ortho-tartaric acid in the above solution increased after standing two months, from 74·6 to 90.

4. "*Influence of Sulphuric Acid on the Crystallisation of Tartaric Acid.*—Sulphuric acid considerably diminishes the solubility of tartaric acid. Much more tartaric acid crystallises out from a saturated solution in dilute sulphuric acid than from a hot saturated aqueous solution : the latter deposits only 50 per cent of its tartaric acid on cooling, whilst a hot solution in 1 vol. of water, and 1½ vols. of oil of vitriol, deposits 70 per cent of its tartaric acid.

5. "*Actions of Solutions of Potassium and Sodium Sulphates on Calcium Tartrate.*"—In the ordinary manufacture of tartaric acid, moist gypsum is added to decompose neutral tartrate of potash and precipitate calcium tartrate. Under certain conditions this reaction is reversed, and if the solutions of potassium or sodium sulphate be sufficiently strong, practically the whole of the tartaric acid in calcium tartrate may be brought into solution as potassium or sodium tartrate.

6. "*Destruction of Citrates and Tartrates by Peroxide of Hydrogen.*"

7. "*Destruction of Neutral Tartrates when their Solutions are Heated with Iron Salts.*"

8. "*Determination of Free Sulphuric Acid in Tartaric Acid Liquors.*"– To ascertain when enough sulphuric acid has been added to decompose the calcium tartrate, the workman usually adds a few drops of calcium chloride solution : if a precipitate appears in a few minutes, free sulphuric acid is present. It is proved in the present paper that this test with certain precautions as to time and dilution may be used quantitatively.

9. "*Determination of Tartaric Acid by Precipitation as Acid Potassium Tartrate.*"—The ordinary method consists in the precipitation of tartaric acid with an excess of potassium citrate, washing the precipitated bi-tartrate with a 5-per cent solution of potassium chloride saturated with bi-tartrate, and determining by titration the acidity of the precipitate. This method is subject to two errors, one of excess due to the precipitation of an acid citrate, and one of deficiency due to the solubility of bi-tartrate in solutions of citric acid and potassium citrate. The author concludes that in all accurate determinations it is necessary to make preliminary experiments with graduated quantities to potassium citrate to discover the proportion which gave a precipitate of maximum acidity. This being ascertained, a final determination was made with this quantity, the precipitate thoroughly washed, and its acidity determined. If much sulphuric acid is present the result is usually about 1 per cent in excess of the truth.

10. "*Detection of Tartaric Acid in the Presence of Citric Acid.*"—Cailletet's bichromate test (*Chem. Soc. Journ.* abstracts, 1879, 674) gives satisfactory results.

11. "*Determination of Organic Acids from the Neutralising Capacity of the Ash of the Salts.*"—With potassium or sodium salts the ignition must be effected by a spirit-lamp, *i.e.*, at a low temperature, to avoid loss.

12. "*Standardising of Alkali used in Titration.*"—The best material for this purpose is acid potassium tartrate : it is easily prepared pure, can be dried at 100°, is not hygroscopic, and being of low acidity a large weight can be taken.

Mr. C. F. Cross then communicated briefly the three following papers :—

"*Contributions to the Chemistry of Bass Fibres,*" by C. F. Cross and E. J. Bevan. The authors detail further experiments, showing that lignified fibres are to be regarded as a chemical whole rather than the mixture which is involved in the incrustation theory. Fractional solution in the Schweitzer-Pelouse reagent and precipitation by acid gives amorphous modifications of the fibre substance, exhibiting uniformity in characteristic properties. With respect, moreover, to the property of giving a yellow colour with aniline sulphate, a diminution was observed, and, after a second precipitation, it had disappeared. That this reaction was not due to the lignose itself, but to some product of its decomposition, was confirmed by other experiments. The authors find that the mairogallol of Stenhouse and Groves gives with sodium sulphite the brilliant colour reaction characteristic of chlorinated derivatives of lignose. This, together with similarity of formula, points to a probable connection between the aromatic derivatives of fibres and the trihydric phenols. The authors describe a higher chlorinated derivative of jute, $C_{38}H_{44}Cl_{11}O_{16}$, a body of identical formula, being obtained from *Musa paradisiaca*.

"*On the Oxidation of Cellulose,*" by C. F. Cross and E. J. Bevan. By the action of boiling 60 per cent nitric acid cellulose is converted into an amorphous substance, which swells up on washing to a gummy mass. On analysis it gave constant numbers, although obtained from various sources, indicating the formula $C_{18}H_{26}O_{16}$. The authors propose the name oxy-cellulose. This substance yields a tri-nitric ether. In this and other properties it exhibits undoubted cellulosic characteristics.

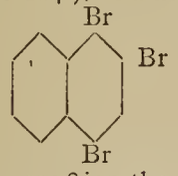
"*On the Analysis of Certain Vegetable Fibres,*" by C. S. Webster. The author has investigated the following fibres :—*Ananassa S.*, *Musa P.*, *Agave*, *Phormium T.*, *Bœhmeria P.*, *Crotalaria J.*, *Linum U.*, *Urtica H.* His results comprise ultimate elementary analyses, determinations of cellulose by chlorination, and a statement of general properties and reactions. None of these fibres appear to preserve the definiteness and uniformity of the jute fibre.

Mr. Warington asked whether the jute fibre was entirely soluble by repeated treatment with bromine and ammonia.

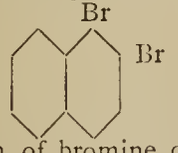
Prof. Thiselton Dyer said that he was much indebted to the authors for the explanations which they had given him from time to time of their work in the Jodrell Labo-

ratory at Kew. There was no doubt that the field which lay in the borderland between vegetable physiology and organic chemistry, and in which these chemists had worked, was regarded by many scientific men with the greatest curiosity. The botanists arrived at various results empirically, and were obliged to make up a sort of spurious chemistry to explain them. Thus, in some way, cellulose is converted into lignin ; the chemist infers that cellulose is related to starch, and some believe that starch is the starting-point of plant life. This position is challenged by Strasburger, who thinks that cellulose and starch are formed by the breaking up of proteids. It seemed admitted by the chemist that the subject was one of the greatest importance, and yet when one turns to chemical books we find the crust of the subject scarcely broken, the voice of the chemist is silent where the botanist ardently desires information. He was therefore only too glad when two chemists expressed their intention of, at any rate, driving a furrow into this unknown tract. The botanist met constantly with such common substances as starch, cellulose, lignin, mucilage, &c., and yet our state of knowledge about these substances was such that he was almost ashamed to ask a question about them at an examination.

"*On the Constitution of some Bromine Derivatives of Naphthalene*" (Third Notice), by R. Meldola. A careful comparison has been made by the author between Glaser's α-dibrom-naphthalene, produced by the direct action of bromine on $C_{10}H_8$, and the author's meta-dibrom-naphthalene (melting-point 64°), and he concludes that these two modifications are isomeric and not identical. β-dibrom-naphthalene (m.-p., 81°) has been obtained by the diazo-reaction from Rother's brom-naphthyl-amin, thus confirming the view that this modification is a para-compound. By means of the diazo-reaction a new tribrom-naphthalene has been obtained from the author's dibrom-naphthyl-amin. This substance forms white needles (m.-p., 113° to 114°), and has the constitution—



By means of the diazo-reaction the author has obtained a new dibrom-naphthalene from Cosiner's brom-β-naphthyl-amin ; it crystallises in oblique rhombic prims, melting at 63°, and is an ortho-compound of the formula—



By the further action of bromine on ortho-brom-β-acet-naphthalide, the author has prepared a tetra-brom-derivative, of m.-p. 138°. By brominating para-nitracet-naphthalide a mono-brom-derivative has been obtained, is meric with that of Liebermann and Scheiding ; it forms pale yellow needles, m.-p. 224° to 225°. The author proposes that naphthalene derivatives, in which the substituents are in the same benzene nucleus, should be called *homonucleal*, and those in which they are in different nuclei *heteronucleal*. It seems to be a general rule that the homonucleal di-derivatives melt at lower temperatures than their heteronucleal isomerides. Thirty specimens of naphthalene derivatives obtained in the course of this and former investigations, were exhibited by the author.

"*On the Constitution of Lophin*," by F. R. Japp. Radziszewski has communicated (*Chem. Soc. Journ.* Abstracts, 1882, 1063) a new synthesis of this substance by the interaction of benzyl, benzaldehyd and ammonia, and he comes to the conclusion that lophin has the constitution—

$$\begin{matrix} C_6H_5-C=N \\ \quad\quad | \\ C_6H_5-C=N \end{matrix}\!\!>\!CH-C_6H_5,$$

and rejects the formula proposed by the author, which represents this substance as belonging to the class of anhydro-bases described by Hübner. This latter formula was based by the author chiefly on certain analogies drawn from the reactions of phenanthraquinone with aldehyds and ammonia, and in the present paper it is shown that these analogies are well founded, and that the formula explains the known reactions of lophin more consistently than that of Radziszewski. In conclusion the author describes an experiment which, though not absolutely conclusive, affords a strong presumption in favour of the anhydro-base formula. If it were possible by heating lophin with hydriodic acid and amorphous phosphorus, to split up this body, Radziszewski's formula should yield benzaldehyd, which should be reduced to toluene ; the anhydro-base formula should yield benzoic acid. Lophin, when thus heated to about 300°, does yield benzoic acid. This temperature, though high, is 100° below the temperature at which lophin boils without decomposition.

The Society then adjourned to December 7, when a ballot for the election of Fellows will be held, and the following papers will be read :—"On the Condensation-Product of Phenanthraquinone with Ethylic Aceto-acetate," by F. R. Japp and F. W. Streatfield. "On the Condensation-Products of Œnanthol," Part I., by W. H. Perkin, Junior. "On the Formula of Lophin, by H. E. Armstrong. "On the Molecular Weight of Basic Ferric Sulphate," by S. U. Pickering. "On Certain Brominated Compounds obtained in the Manufacture of Bromine," by S. Dyson.

THE METEOROLOGICAL SOCIETY.

The opening meeting of the Session was held on Wednesday evening, the 15th inst., at the Institution of Civil Engineers, Mr. J. K. Laughton, F.R.A.S., President, in the Chair.

Eleven new Fellows were elected, viz. : Rev. J. Branskill, F. B. Buckland, C. F. Casella, W. H. M. Christie, F.R.S., A. Cresswell, R. S. Culley, C. Morris, O. L. O'Connor, H. Parker, F.Z.S., A. Rowntree, and D. R. Sharpe.

The papers read were :—

"*On Certain Types of British Weather*," by the Hon. Ralph Abercromby, F.M.S. The author shows that there is a tendency of the weather all over the temperate zone to occur in spells, associated with certain types of pressure-distribution. In Great Britain there are at least four persistent types—the southerly, the westerly, the northerly, and the easterly. In spite of much fluctuation, one or other of these types will often continue for weeks together, and tend to recur at the same date every year. The value of the recognition of type groups is shown in the following ways :—(1.) They explain many phenomena of weather and many popular prognostics. (2.) In some cases they enable forecasts to be issued with greater certainty and for a longer time ahead. (3.) We can by their means correct statistical results, by giving the real test of identity of recurrent weather, which no single item, such as heat, cold, rain, &c., can do. (4.) They enable us to treat such geological questions, as the influence of changing distribution of land and sea on climate, in a more satisfactory manner than any other method.

"*On the Use of Kites for Meteorological Observation*," by Prof. E. Douglas Archibald, M.A., F.M.S. In this paper the author advocates the use of kites for meteorological observation, and describes the mode in which they may be best flown so as not to be mere toys, but scientific instruments, capable of ascending to great heights, remaining steady in currents of varying velocity, and of being manipulated with ease and rapidity by the observer.

"*The Meteorology of Mozufferpore, Tirhoot, 1881*," by Charles M. Pearson, F.M.S.

NOTICES OF BOOKS.

Messrs. Letts's and Co.'s Diaries for 1883.

These annual visitors have once more made their appearance, undiminished ln utility and finish, or rather in some cases improved in both. Letts's Gentlemen's Pocket Diary and Almanac (No. 18) in Russian wallet, is substantially but tastefully got up. In addition to the diary, two pages to the week, and a number of blank leaves for memoranda, it contains an almanac, information concerning passports, Inland Revenue duties, University and Law Terms, Customs' tariff, stamp duties, postal information, Officers of State, tables of Sunday Lessons, and other useful information.

Letts's "Housekeeper Enlarged and Engagement Book" contains a ruled space for every day in the year for registering payments made to tradesmen. There is a "concise directory" containing the addresses of 62 firms only. This feature, we are told, has been inserted "under the impression that it will prove of utility to country and foreign residents who may desire to communicate with *a respectable firm* in any particular trade or profession, and have no means at hand of knowing whom to address." It is not easy to discover why some particular trades have been entirely omitted, nor on what principle the firms mentioned have been selected. It is not often, we think, that foreign residents will "desire to communicate" with a *hair-cutter* in London. There are registers for the engagements of servants, for gas consumption, for articles lent—a very useful feature.

The Medical Diary is a tall, narrow volume, containing thermometric tables, instructions for the treatment of persons apparently drowned, poisons and their antidotes (in which the compounds of chromium are omitted), a classified list of medicines, average weight and measurement of healthy organs, weight of body, hypodermic injections, therapeutic equivalents, and professional fees. These, as far as concerns attendance before courts of justice, strike us as decidedly too low, a point which we consider ourselves at liberty to notice because the same scale has been held applicable to chemical analysts, microscopists, and other scientific experts.

Letts's Office Diary and Almanac (No. 9) is arranged for the commercial public. It contains lists of banks, for London, the Country, the Colonies and Foreign States, and the usual assortment of statistics, &c. We find also the same curious "concise directory" which we noticed when speaking of the "Housekeeper." This feature seems the more out of place, as offices are seldom unprovided with a London directory.

The Metallic Diary (No. 61) is a neat little pocket volume, containing merely a very concise almanac, a diary allowing alternately three and four days to the page, with spaces for memoranda and things "lent."

Diary No. 13 is a volume bound in cloth, and intended rather for the table than the pocket.

Letts's Pocket Diary and Almanac, a small volume in pocket-book shape, but unprovided with any distinguishing number or mark, contains seven days to the page.

No. 31 is a large-sized, so-called rough, diary or scribbling journal. It contains alternately three and four days to the page, twelve lines being allotted for all the days except Saturday and Sunday.

No. 33 is a very similar publication.

All these diaries are well printed on good paper. Those which we have examined are but a small selection out of a long list arranged to suit every taste, every purpose, and every requirement as regards price.

The School of Mines, Ballarat. Annual Report presented at the Meeting of Governors, held January 24th, 1882. Published by Authority.

The subjects taught in this institution are chemistry, in the widest sense of the word, metallurgy, geology, palæontology, mineralogy, scientific mining (including geological surveying), practical mining, mathematics, physics, telegraphy, botany, materia medica, pharmacy, and physiology. The four last subjects, unusual in a mining school, which are explained by the circumstance that the institution serves also as a pharmaceutical school. The staff of Professors is not large—we fear from want of funds. Thus we find Prof. A. M. Smith filling at once the chairs of chemistry, metallurgy, physics, and botany. Prof. M. F. Krause is not less burdened. He teaches not merely geology, mineralogy, palæontology, and scientific mining, but geological surveying, land, mining, and engineering surveying. The services of the lecturer in Oil-painting—a curious feature in a mining school—have been dispensed with.

The museum and the library have been enlarged, but we regret to note that the balance in favour of the School was smaller at the end of 1881 than was the case twelve months previously.

Tables for the Qualitative Analysis of Simple Salts and Easy Mixtures, for the Use of Students Preparing for the Government Science, Oxford and Cambridge Local Examinations, &c. By Joseph Barnes, Science Master at the Bolton High School. Galt and Co., Manchester. London: Simpkin, Marshall, and Co.

This work consists of 47 pages, and is arranged for "boys and young men who are only able to work in the laboratory for an hour or two during the week." The instructions given, so far as we have been able to examine them, appear accurate. But we fail to see that they have any advantage or superiority over what is to be found in other manuals.

CORRESPONDENCE.

TEST FOR UREA.

To the Editor of the Chemical News.

Sir,—Perhaps some one of your readers will be kind enough to mention a good qualitative test for the presence of urea in a solution containing (besides urea) metallic salts. The process of evaporating down in the water-bath and then adding pure nitric acid is tedious, and in cases where one is limited to time, scarcely available.—I am, &c.,

R.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 18, October 30, 1882.

Result of Experiments made at the Electrical Exhibition on Machines and Regulators with Continuous Currents.—MM. Allard, Joubert, Le Blanc, Potier, and Tresca.—The chief results of these experiments are given in the form of a table.

Rational Conception of the Nature and Propagation of Electricity, deduced from a Consideration of the Potential Energy of the Ethereal Matter associated with Ponderable Matter, and from the Mode of Production and of Transmission of Work accompanying the Variations of this Energy.—A. Ledieu.—Continued from *Comptes Rendus*, October 16.

Efficacy of Lightning Conductors.—G. A. Hirn.—The author describes an incident showing that a lightning-rod, even in the most deplorable condition, may sometimes effectually protect an edifice.

Application of the Law of Complementary Colours to the Transitory Decolouration of Yellow Diamonds.—MM. N. Chatrian and Jacobs.—Yellow diamonds may be made to appear white by immersion in the solution of a violet dye. Washing of course removes the film of violet colour, when the original yellow tint reappears.

Chemical Studies on the Sugar-Beet.—H. Leplay.—Studies on the distribution of potassium and calcium salts at different epochs of vegetation.

New Expressions of the Work and the Economic Return of Electric Motors.—Marcel Deprez.—A mathematical paper.

A Modification in the Expression of the Law of Isomorphism.—D. Klein.—The author proposes to modify the statement of the second part of the law in the following manner, as already suggested by M. de Marignac: Isomorphous bodies have either a like chemical composition or present a centesimal composition, differing respectively but little, and containing a group of elements which are either common or of identical chemical functions, forming much the greater part of their weight.

Researches on the Thorite of Arendal.—L. F. Nilson.—This paper will be inserted at length.

Rapid Process for the Determination of Salicylic Acid.—A. Rémont.—To determine salicylic acid, *e.g.*, in wine, the author takes 10 c.c. and agitates them in a test-tube several times with an equal volume of ether, allowing the mixture finally to stand for some time. He then takes 5 c.c. of the ethereal solution and evaporates it with 1 c.c. of water. After the ether has disappeared he makes the solution up to 5 c.c. by pouring the liquid and the washing-water into a graduated tube, of the capacity of 30 c.c., and of the internal diameter of 0·015 metre. Into a tube exactly similar he pours 5 c.c. of a type liquid prepared by dissolving in pure wine the largest quantity of salicylic acid allowed by law, *i.e.*, 0·15 grm. per litre. This type, or standard liquid, the author treats with ether and then with water, exactly as described above. He then adds both to the standard liquid, and to the liquid in question, drop by drop, a dilute solution of ferric chloride (10 grms. of the salt per litre). About three drops are generally sufficient. The depth of colour in the two tubes will show whether the lawful quantity of salicylic acid has been exceeded.

Presence of Ammonia in the Air and in Atmospheric Watery Vapours at Great Heights.—A. Muntz and E. Aubin.—The authors have made their observations on the summit of the Pic du Midi, at 2877 metres above the sea-level. They find the proportion of ammonia substantially the same as what has been observed on the surface of the ground.

Deutsch-Amerikanische Apotheker Zeitung.
Vol. iii., No. 11, August 15, 1882.

Artificial Vanilline.—Dr. Otto Grothe.—Benzaldehyd obtained by heating benzotrichloride with lead nitrate is converted into meta nitro-benzaldehyd. This is transformed into the amido-compound by means of tin and hydrochloric acid. It is then converted into the diazo-compound and the diazo-group is converted into the hydroxyl-group by boiling. The substance thus obtained is evaporated to dryness with sodium hydrate and the result is heated with methyl iodide to form the methyl-derivative. The latter is nitrated, amidised, converted into a diazo compound, and yields vanilline on boiling with water.

Purification of Ozokerite.—Dr. Gruber.—In order to obtain from ozokerite a pure white cerosine the author treats 100 parts ozokerite with 5 parts of fuming sulphuric acid at 80°. The black resinous matter which is deposited in 1½ hours is removed, the dark-green liquid is heated with 10 parts of a dilute solution of sodium silicate to 80°, and agitated for an hour at the same temperature. If 200 parts of water are added the emulsion is decomposed and silica separates out, carrying colouring matter along with it. The yellowish-grey cerosine which floats on the surface is skimmed off and mixed with 50 per cent of a new, specially prepared nitro-carbide (?), and left in contact with it at 80°. The mass is then extracted with 40 to 60 per cent of a petroleum ether, boiling at 40° to 60°, and the latter is distilled off, leaving 70 per cent of fine white cerosine. The nitro-carbide (a nitrogenous charcoal?) is regenerated in retorts by known processes, and the residues obtained during the treatment with sulphuric acid are worked up for paraffin and oil.

Detection of Chloroform.—S. Vitali.—The liquid in question is mixed with a little thymol and potassa, when chloroform is recognised by a reddish-violet colour, which becomes more distinct on the application of heat.

New Method of Recognising the Alkaloids in their Salts.—M. Robin.—To determine a mixture of this kind a small quantity is mixed with twice its weight of powdered sugar. The whole is moistened with twice its weight of pure sulphuric acid. Morphine hydrochloric gives a very fine rose-colour which quickly passes into a somewhat persistent violet. Quinine sulphate gives a greenish colour which becomes light yellow and finally displays a brown ground surrounded by yellow rays; atropine sulphate gives a violet colour turning gradually brown. Strychnine gives a reddish colouration which turns to a black-brown. The behaviour of santonine is similar. Narcotin, a permanent mahogany brown; salicine passes from a brown to a splendid red. Veratrine becomes dark-green; codeine gives a fine intense red (not rose-colour) which soon turns violet, and codeine a bright red.

Recovery of Platinum Chloride and Ammonium Molybdate.—Jul. Post.—All liquids containing platinum chloride are collected together and precipitated with a sufficiency of potassium chloride, let settle for 24 hours, the supernatant liquid drawn off, and the precipitate rinsed into a porcelain capsule. Then all residues of potassium-platinum chloride existing on filters are collected, the empty filters are boiled several times with water, and the solution is poured into the porcelain capsule. Sodium carbonate is then added till an alkaline reaction is produced, and the whole is heated for some hours in the water-bath with occasional stirring. As soon as the platinum has formed a black deposit and the liquid retains merely a faint yellow colour from organic matter, the liquid is filtered, the platinum black is washed first with boiling water, then with boiling nitric acid, and then again with boiling water till the liquid is free from chlorine. The precipitate is dried at the ordinary temperature, and may be at once converted into platinum chloride. For regenerating ammonium molybdate the acid and the alkaline residues are collected apart. The acid liquid is drawn off clear and evaporated in a porcelain crucible to about $\frac{1}{10}$ of its bulk. Almost all the molybdic acid is deposited as an incrustation. When cold the acid liquid is poured off, the crust is washed repeatedly with cold water and poured to the acid liquid, and the whole set aside. Next the ammoniacal liquid is drawn off or filtered, added to the crust in the porcelain capsule, and heated till this is dissolved. Then the solution is filtered and evaporated to crystallisation in the water-bath. The crystals of ammonium molybdate are washed with a little water, the washings mixed with the mother-liquor and again evaporated to crystallisation. The crystals are again washed washed with a little water; the washings, the mother-liquor, and the solution set aside are mixed, precipitated with sodium phosphate, and put in the bottles set apart for storing alkaline solution.

Detection of Phenol in Creosote.—For this purpose the following reactions are employed:—According to Rust two-thirds collodion give a clear solution with creosote, but a gelatinous mass with phenol. An alcoholic solution of ferric chloride gives, according to Clark, with creosote a bluish colour, turning to a dark green, but with phenol a brown An aqueous solution of the same salt gives, according to Read, no change, but with phenol a blue colour. Creosote dissolves in glycerin, and is precipitated on the addition of water. Phenol dissolves also, but is not re-precipitated by water. Baryta-water in excess gives a turbid solution with creosote, but a clear solution with phenol.

Journal de Pharmacie et de Chimie.
Tome vi., September, 1882.

New Reaction of Urine and Milk.—M. Ch. Richet.—Potassium iodhydrargyrate is not decomposed by urea or uric acid, but it is instantly attacked by the extractive matters present in urine, and metallic mercury is thrown down in proportion to their quantity. The same reagent is decomposed by milk. Milk contains an imperfectly defined principle, which, like the ptomaines, instantly reduces potassium ferricyanide to ferrocyanide.

Moniteur Scientifique, Quesneville.
September, 1882.

Analysis of Beer.—H. Bungener.—A continuation from the June number. The author treats at length on the determination of alcohol and extractive matter; on the degree of concentration of the wort before fermentation, the determination of the albumenoid matters, the ash, the phosphoric acid, the acidity, and the glycerin; and, lastly, on the detection of antiseptics and of substitutes for hops.

Review of Biological Chemistry.—MM. de Bechi and H. Gall.—A selection of abstracts, chiefly from German journals.

Review of Foreign Chemical Researches.—G. de Bechi.—A series of extracts from the *Berichte der Deutsch. Chem. Gessel.* and the *Annalen der Chemie.*

Alfred Naquet's Patent.—The specification of a patent for dyeing the hair with preparation of bismuth.

New Apparatus for Filtration.—Paul Casamajor.—From the *American Chemist* and the Chemical News.

The Industrial Society of Mulhouse.—At the meeting of the Chemical Committee, May 10, M. H. Kœchlin read a paper on the fixation of colours by means of double mordants (see Chemical News, p. 179).

M. Goppelsrœder read two sealed papers deposited on March 29 and April 22 last, treating of the use of the galvanic current for the simultaneous formation and fixation of colouring-matters upon the fibre; for discharging colours fixed upon a tissue, and thus producing designs upon a self-coloured ground; for discharging colours and producing simultaneously coloured designs on the discharged parts, *e.g.*, aniline-black upon Turkey-red or vat-blue; preventing the oxidation of colours during printing; preparing solutions of reduced colours, &c.

At the meeting of July 12, M. H. Kœchlin read a paper on the application of pyro-gallo-quinone in dyeing. Pyro-gallo-quinone is formed spontaneously from alcoholic mixtures of quinone and of pyrogallic acid, and is deposited in the course of a few days in the form of brown crystals. For quinone may be substituted chloranil. Pyro-gallo quinone is very soluble in ammonia, soda, and alcohol, but sparingly soluble in boiling water. Sulphuric acid dissolves it with a red colour, which disappears on the addition of water. It gives a black precipitate with salts of iron, and a brownish red one with salts of aluminium. Pyro-gallo-quinone dyes a brown with mordants of alumina and chrome, and a black with iron mordants. These shades resist soaping at a boil and the action of light. The shades are brighter than those of rufigallic acid, which they otherwise much resemble.

The President read a note by M. Jacques on improvements in the manufacture of albumen, and on its decolouration under the action of air, light, and the vapour of turpentine.

M. Noelting communicated, on behalf of M. Prochoroff, an observation concerning stannous acetate. To dissolve stannous oxide relatively large quantities of acetic acid are required. But on adding a certain quantity of ammonium acetate the solubility of the stannous oxide is much increased. There is probably formed a double acetate of tin and ammonium, which for the purposes of the printer has the same properties as those of stannous acetate, and which may be employed with advantage in the reduction of indo-phenol.

Aniline and Alizarin Colours from Petroleum at the Moscow Exhibition.—From the tar obtained in the manufacture of petroleum gas M. Ragosine has exhibited aniline, methyl-aniline, diphenyl-amine, naphthyl-amine, resorcine, rosaniline, saffranine, eosine, phosphine, and paste alizarine containing 10 per cent of actual colour, all obtained from the petroleum of Bahu.

Estimation of Coke and of Volatile Matter in Coal.—From the *Engineering and Mining Journal.*

Manufacture of Bromine.—An account of the process followed in America, taken from the *Engineering and Mining Journal.*

Imitation of Cheese.—T. E. Thorpe.—From *Nature.*

Patents taken Abroad.—Abstracts of the Specifications of certain German and English patents.

Manual of Industrial Hygiene (Review).—Dr. H. Napias.—A notice of a work treating principally on sanitary legislation as regards manufactures, mines, &c.

Hygiene and Maladies of Peasants (Review).—Alex. Layet.—A notice of a treatise on the sanitary condition of rural districts.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., August, 1882.

This issue contains no chemical matter.

Cosmos Les Mondes.
No. 3, September 16, 1882.

The manufacturers of linseed cake in the North of France are said to sophisticate their product with spent maize from the distilleries, from which the oily matter has been extracted.

The Automatic "Vidangeuse" of L. Mouras.—This instrument is described as affording a perfect solution of the sewage question. It is closed with a water joint, and is said to be inodorous, and to render infection impossible. "By a mysterious operation, which reveals a totally new principle, it transforms all the solid and liquid excreta which it receives in a short time, and without the addition of any chemical agents, into a homogeneous liquid scarcely turbid or coloured, and almost inodorous, holding everything in suspension in the state of filaments or granules almost invisible." The effluent which contains all the elements of the excreta, organic or inorganic, may be used for irrigation. Experiments made with a "vidangeuse" with glass sides are said to have proved that fœcal matters introduced along with urine, soap-suds, &c., are completely reduced at the end of twenty-five days (?) Light substances, such as paper after having floated for a certain time, finally disappear and are dissolved in the liquid mass. A bladder adapted by means of a tube above the experimental vidangeuse does not swell out, but shrinks, showing that instead of liberation of gases there is absorption. All this is effected

"without having recourse to any new agent or any strange force, but by the simple fact that the pan closed and filled with water brings into play a force of nature hitherto unforeseen and overlooked."

No. 4, September 23, 1882.

The Reducing Action of Glycerin upon Salts of Silver and the Application of this Phenomenon to Silvering Glass.—Prof. Palmieri.—On adding glycerin to an ammoniacal solution of silver nitrate, after some time the liquid becomes brown, deposits a black substance, and then becomes limpid and colourless. On heating the mixture it takes a deeper and deeper brown colour, turns black, and leaves a steel-grey metallic deposit upon the sides of the test-tube. If to the mixture of glycerin and of ammoniacal solution of silver nitrate there are added a few drops of caustic potassa and the whole is left at rest, after a short time there is a reduction of silver, forming a very brilliant precipitate. It is preferable to add the potassa to the silver solution before pouring in the glycerin. As soon as the liquids come in contact. reduction sets in; a moderate heat greatly favours the brilliance of the precipitate. If to the above ingredients ether is added, a metallic ring is at once observed at the point of contact, and in a few seconds the reduction spreads through the whole mass. Agitation renders the reduction more uniform. If alcohol is used instead of ether the reduction is more rapid, and the mirror is very brilliant. The actions of light and heat modify this reaction. Darkness renders the mirror more brilliant and adhesive. With potassa alone the best result is obtained between 60° and 70°; with potassa and ether, between 30° and 35°; and with potassa and alcohol, between 40° and 45°. The reaction is complete in from eight to ten minutes.

No. 5, September 30, 1882.

Easy Method for the Analysis of Sodium Hydrocarbonate.—Dr. Lange.—The author first determines the quantity of soda by the ordinary method. He dissolves then 20 grms. of the sample in a litre of cold water, takes 50 c.c., and titrates it alkalimetrically. He adds to the liquid, whence this portion was taken, a determined quantity of ammonia in order to transfer the bicarbonate into a mixture of neutral ammonium carbonate and sodium carbonate. The excess of ammonia remains free. The ammonia used must be free from ammonium carbonate, a condition which constitutes the chief practical difficulty of the process. If barium chloride is added to the solution in sufficient quantity, the sodium and ammonium carbonates are converted into barium carbonate, which is precipitated, and into chlorides. The alkali due to the excess of ammonia remains in the liquid. The quantity of this free ammonia is then determined with the same standard acid which has been used for the alkalimetrical process, and the quantity of bicarbonate present in 50 c.c. of the liquid is found by calculation.

No. 6, October 7, 1882.

The deaths are announced of M. Désiré Van Monckoven, well known for his labours in the application of photography to astronomy, and of Georges Leclanché, the well-known electrician.

A paragraph, taken from an American paper, speaks of a hailstone, weighing 80 lbs., which fell near Salina, in Kansas. There were others weighing 4 to 5 lbs.

M. Nordenskiold maintains that the aurora is a permanent phenomenon in polar regions, being always seen when the sun is below the horizon and when the moon is invisible.

A New Micro-telephonic System.—Prof. Celso Fornioni.—This paper requires the accompanying illustration.

Electric Incandescence Lamps (Continued).—Mr. Swan.—Translated from an English source.

Felspar as a Source of Potash Alum.—John Spuller.—From the *Journal of the Franklin Institute.*

MISCELLANEOUS.

Society of Arts.—The following are the papers which will be read at the Wednesday evening meetings of the Society of Arts, before Christmas:—November 22. J. Hopkinson, D.Sc, F.R.S., "Ice-making and Refrigerating" (Dr. Siemens, F.R.S., Chairman of the Society's Council, will preside). November 29, Sir Frederick Bramwell, F.R.S., "Some Points in the Practice of the American Patent Office." December 6, William A. Gibbs, "The Artificial Drying of Crops." December 13, W. H. Preece, F.R.S., "Electrical Exhibitions." December 20, P. L. Simmonds, "The Utilisation of Waste: A Quarter of a Century's Progress."

An Improvement in Mercurial Thermometers.—Mr. S. G. Denton, F.M.S., 25A, Hatton Garden, has just exhibited, at the Meteorological Society, 46 newly-made mercurial thermometers, constructed in a special manner, the zero of which has remained constant for over twelve months. The thermometers comprised 23 standards and 23 clinicals. To prove that they were newly-made, the pieces of enamel stems were sent to the Kew Observatory and Hall marked, previous to having their bulbs blown. They were then constructed into thermometers, graduated, and returned to the Observatory, and tested throughout. They were then placed under seal by the Superintendent, and remained so for over twelve months, and then again re-tested, the mean amount of change being only about half a tenth of a degree Fahrenheit. A Standard thermometer, made by the same process as above, was also shown, it being verified in 1873 and in 1882, the zero being still constant.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Aniline Dyes.—Will any of your readers tell me of a good work on the chemical analysis of these dyes?—T. B. M.

Vacuum Pump.—I notice in the CHEMICAL NEWS of the 27th October an article on some experiments with a patent vacuum pump refrigerator and ice machine at the premises of the Aylesbury Dairy Company, and I shall be extremely obliged if you will kindly inform me whose patent this is, and whether I can obtain a specification of the invention?—W. J. H.

Manufacture of Pure Chemical Reagents.—(Reply to "A.C.")—I do not know if the work of MM. Gérard and Chancel (Rector and Professor of the Academy of Medicine at Montpellier), entitled "Leçons de Chimie," in two parts in 18mo, has been translated into English. This is a work which should answer your purpose very well; it is exclusively for manipulation and the preparation of chemicals for laboratory use. If you are in London, and will call at Messrs. Hachette and Co.'s Library, perhaps these gentlemen will advise you about it.—B. BOISSON.

MEETINGS FOR THE WEEK.

SATURDAY, 25th.—Physical, 3. "On Liquid Slabs," by Dr. F. Guthrie. "On Rainbows formed by Reflected Light," by W. Ackroyd.

MONDAY, 27th.—Medical, 8.30.

TUESDAY, 28th.—Institution of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.

WEDNESDAY, 29th.—Society of Arts, 8. "Some points in the Practice of the American Patent Office," by Sir F. Bramwell, F.R.S.

THURSDAY, 30th.—Royal, 4. (Anniversary).

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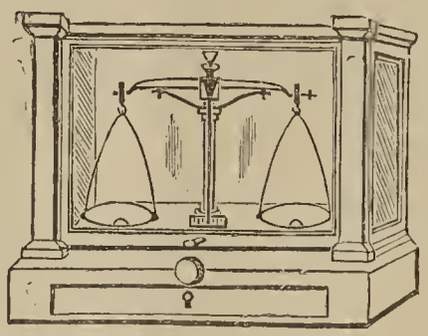

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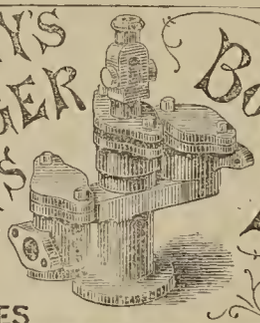

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THE CHEMICAL NEWS.

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ON A NEW FORM OF APPARATUS FOR ESTIMATING AMMONIA IN POTABLE WATERS.

By C. R. TICHBORNE. LL.D., F.C.S., &c.

According to the generally accepted method of examining potable waters, the estimation of minute traces of ammonia existing as such, and the ammonia which results from the oxidation of nitrogenous organic matter, are looked upon as being of the greatest importance in arriving at a conclusion as regards the quality of the water. The process may be concisely described as distilling off a third of the water, and estimating the ammonia in the distillate by Nessler's delicate process, which leaves nothing to be desired as regards its accuracy.

As the amount to be determined does not much exceed one part in ten million parts, it is evident that it is necessary to avoid any accidental contamination from atmospheric ammonia. This is particularly the case in chemical laboratories, where ammoniacal solutions are constantly undergoing evaporation, and the air is contaminated with that volatile base.

The fact is, of course, well recognised by all expert analysts, and is generally guarded against by the use of a special cupboard or chamber, in which the whole operation can be performed. Such a method is more or less imperfect, because the gas-burner used will itself, under certain conditions, become a source of ammonia. Also, it is evident that a general ammoniacal atmosphere in the adjacent laboratory will find its way into the chamber by the ordinary laws of diffusion.

The capacity of the vapour of water (when in the act of condensing) of absorbing traces of ammonia is something extraordinary, and can only be appreciated by the practical worker.

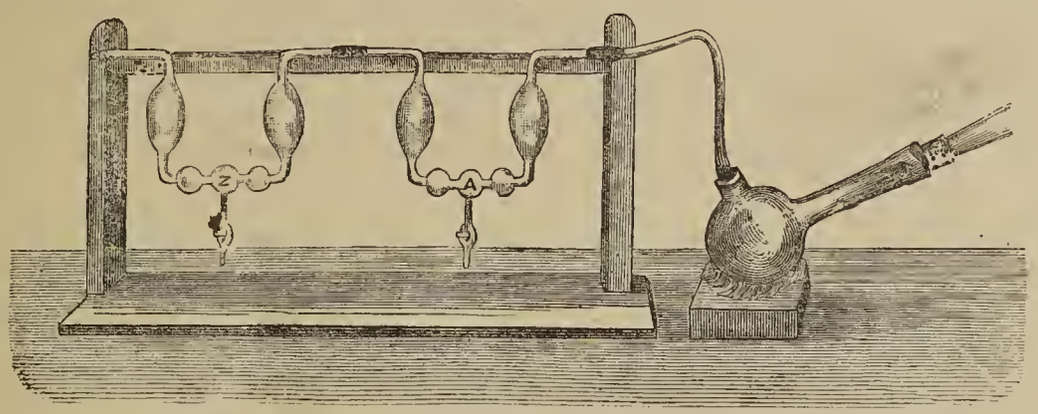
In distilling potable waters, I was accustomed to work with an ordinary retort and receiver—the latter being provided with a specially contrived mercurial valve. Now, although this was satisfactory in closing the interior of the retort and receiver from general contact with atmospheric impurities, occasionally a regurgitation would take place, and admitted a little of the laboratory air.

The following arrangement has been lately adopted by myself, and, both as regards simplicity and efficacy, leaves nothing to be desired. It is, in fact, so simple that, to a superficial observer, my communication might at first sight appear superfluous, but the importance of the question involved renders any apology unnecessary.*

At ordinary temperatures very weak solutions of ammoniacal gas (such as we have to deal with in the analysis of potable waters) are fairly permanent; but, in the gaseous conditions, owing to the different tensions of the vapour of the water and ammonia, this stability no longer exists. Again, small traces of ammonia in the gaseous condition are instantly absorbed by water in the non-gaseous condition. These are the two equal sources of error to be guarded against in the distillation of ammonia from potable waters, and, bearing these two points in view, I adopted the arrangement figured.

It consists of a retort fitting into a fairly long-necked receiver, with an india-rubber stopper. The arrangement must be air-tight. The receiver is connected with a bent tube proceeding from its stopper, and connecting it with two bulb tubes of a special form, and marked respectively A and *z*. This marking is to prevent any confusion in the hurry of manipulation, as they are exactly the same shape. The bulb-tubes are somewhat similar to a flat Liebig's potash bulb, but with two pear-shaped bulbs on each side, to prevent regurgitation of the fluid, and three absorption bulbs at the bottom. The centre bulb of these three is provided with a glass tap for filling and emptying the apparatus.*

The water to be examined is poured into the retort, and one-third distilled over gently, but at a fairly good rate. If operating upon half-a-pint, the operation should take about an hour. The whole apparatus is previously connected together, and the two bulbs are filled with water free from ammonia (*i.e.*, water which has been boiled rapidly in a flask, until it gives no reaction with the Nessler reagent). The bulbs are easily filled by opening the tap, inserting the point of the tap tube into a beaker of the water, and sucking with the breath gently—at the same time stopping the other end of the bulb-tube by the finger.



After the operation is completed, you have the most of the ammonia, if not all, in the receiver, whilst any vapour which might have escaped therefrom is caught in the tube A; at the same time, any atmospheric ammonia which enters by regurgitation is caught in the bulb-tube *z*. A is run into the distillate in the receiver, whilst *z* is rejected. In practice, it is not necessary that the water in *z* should be changed for twenty or thirty operations, providing that an abnormal amount of ammonia is not about in the laboratory atmosphere; but if so, it is desirable to change with each experiment.

If we consider the points that I have dwelt upon as being sources of error, we shall see that this simple apparatus fulfils absolutely the necessary conditions, and that the tube connecting the bulbs A and *z* *contains an atmosphere perfectly neutral as regards ammonia*, because it is the space between two liquids which do not give off ammoniacal gas, and which give off vapour of an equal tension.

* "Roscoe and Schorlemmer's Treatise on Chemistry" is one of the most important works upon that science recently issued. In their description of the determination of ammonia in potable waters, there is no provision against this fruitful source of error. If the determination were carried on as it is figured at p. 252, vol. 1, of that work, the results would be utterly unreliable in any laboratory where other analyses were being performed.

* Bulbs of my pattern are made by Messrs. Cetti & Co., of London.

I may mention that, on submitting it to experimental proof, the use of an acid in either of the bulb tubes proved a mistake.

It is not necessary to give further details, but I may as well state that in many crucial experiments I have been in the habit of estimating the amount of ammonia in the receiver, and both bulbs A and *z*. The following, as regards Vartry water, will serve as an illustration :—

Distillate in receiver, ... 0·003 per 100,000
Bulb A (nearly) .. .. .. 0·001 ,,
Bulb *z* gave an indication which affected the Nessler, but which was not sufficient to estimate.

—*Scientific Proceedings of the Royal Dublin Society.*

ANALYSES OF TOBACCO ASH.

By R. ROMANIS, Chemical Examiner.

The Government of Burmah are now trying to promote the cultivation of tobacco. I have had occasion to analyse the ash of tobacco grown on different soils in Burmah and in India.

I.—Mengone tobacco grown on the granitic soils near Mandalay, in Upper Burmah.

K_2O	17·88
Na_2O	4·12
NaCl	0·74
CaO	27·27
MgO	7·58
$Fe_2O_3P_2O_5$	6·94
SiO_2	24·53
SO_3	10·92
	99·98

II.—Grown on alluvial soil at Karrawaddy, in Lower Burmah.

	Midrib.		Leaf.
K_2O	31·49	K_2O	22·65
KCl	2·55	N_2O	4·45
NaCl	1·84	NaCl	1·09
CaO	28·93	CaO	20·78
MgO	6·64	MgO	8·90
SO_3	4·40	SO_3	7·35
$Fe_2O_3P_2O_5$	12·58	$Fe_2O_3P_2O_5$ ..	10·27
SiO_2	11·56	SiO_2	24·56
	99·99		100·05

III.—Indian tobacco.

	Midrib.		Leaf.
K_2O	32·19	K_2O	19·02
KCl	0·63	KCl	0·40
CaO	37·40	CaO	36·51
$MgOP_2O_5$ ..	11·95	$CaO.P_2O_5$ ..	8·84
MgO	6·12	MgO	7·31
SO_3	4·62	$Fe_2O_3P_2O_5$ ..	7·76
SiO_2	6·19	SO_3	6·50
		SiO_2	13·76
	99·10		100·10

PYROLOGICAL NOTES.

By Lieut-Colonel W. A. ROSS late R.A.

V. On the Use of Boric Acid as a Reagent.

It may be advisable here to explain in detail the *rationale* of the chemical action of this reagent upon substances treated in it before the blowpipe, using the two pyrological examinations of *acmite* (described in the last paper) as an illustration of the difference between its results and those of the reagent chiefly in use at present in Germany —borax.

(1.) In borax, as is well known, almost every composite or mineral powder added before the blowpipe is more or less completely and rapidly dissolved; when, a general *melange* of contents taking place, that constituent alone which by a stronger colour in solution or other means overpowers the indications of the rest can be recognised. But this is not the only, or even the least serious, drawback to the use of borax as a blowpipe reagent. A reference to Plattner's celebrated blowpipe tables (last edition) shows that out of forty-three pure oxides, whose reactions in borax are described in detail at a great expense of paper and type, only six, or, if the miserable "brown" afforded by oxide of nickel is considered "a good indication," seven can be detected, even when alone, by the use of this reagent, and of these six, three—chromium, vanadium, and uranium—afford the *same* colour—green! Again, what can be a more absurd "test" for the presence of an oxide if it requires, even when pure, to be added to a borax bead in comparatively enormous proportion to give any indication at all, as in the case of iron oxide?

When, on the contrary, a mineral powder is added to a bead of *boric acid* before the blowpipe, three very important phenomena are almost instantaneously offered to the attention of a good observer provided with a decent lens; many more are, of course, presented to the observer provided with a good microscope, but I shall refer to that matter hereafter. (1.) The normal green pyrochrome or coloured flame is *altered* by the merest trace of some substances, as copper. (2.) Effervescence takes place with sulphates as well as with carbonates,—an immense advantage, for they are easily distinguished afterwards. (3.) Insoluble borates of added bases are formed within the bead, differing widely, in almost every instance, from each other, in form, colour, and structure. The assay balance shows us that some of these, as lime-borates (which appear in the shape of transparent colourless balls or sphericles), are precisely four times the weight of their basic oxides, increasing, of course, very much more proportionally with regard to bulk, so that the merest trace of lime or calcium phosphate (for instance)—as that floating in the dusty air of a room, or in part of a fly—can be not only here recognised by its borate, but, if the observer's balance be delicate enough, quantitatively determined.

Here I may refer to the objection of minuteness urged against this mode of analysis by many chemists, who forget that they are in this objecting not so much to the use of the blowpipe, as of the microscope in chemistry.

The chief action of boric acid, therefore, before the blowpipe, it will be seen, is that of *separation*; precisely the opposite faculty to that of borax, which is to mix everything together. Thus, in a single rapid operation, the pyrologist using boric acid effects—microscopically, but still effects—in many cases what the laboratory chemist can only arrive at by many careful and patient processes of solution, precipitation, filtration, &c., in which a single error or misapprehension, or omission, may render useless the work of hours or even days.

Then, again, there are secondary results, less important than the primary one of separation, but still of great value to the practical chemist or mineralogist. Borax, as is well known, is boric acid combined with a large proportion of basic sodium; the reactions of soda (or other alkali), therefore, contained in minerals, is utterly lost to the pyrologist who uses it as a reagent; he certainly has the "yellow flame B.B." in the case of soda, but considering this is afforded more or less by every silicate and by all silica, the reaction is nearly useless to him. Now, those alkaline aluminous silicates which generally gelatinise with hydrochloric acid (the "zeolites") behave almost similarly in boric acid before the blowpipe; their powder almost immediately "forms an ice-like transparent mass or jelly," dissolving (rapidly or slowly, according to the proportion of silica and alkali) "to a colourless vitreous bead." As this never happens when either of the three oxides, silica, alumina, or alkali, is absent, the phenomenon is obviously a certain and delicate test of the

* Therefore the guano contains about 12¼ per cent of nitrogen.

combined presence of these three substances. By fusing the mineral before the blowpipe (and such minerals nearly always fuse), crushing it, boiling the powder in distilled water (which process removes the greater part of the alkali as soluble alkaline silicate), and treating the residue in a phospho-boric" bead—that is, a boric acid bead dipped red-hot in pure phosphoric acid—*separation* again occurs; silica and alumina appear together as aluminium silicate in the shape of "white, opaque, unattacked fragments"; lime, as transparent balls, opaque hot if magnesia is present, clear hot if pure, pale green cold if even the minutest trace of iron is present, colourless if pure; iron, as brown-black opaque balls with rust-like matter round them; manganese, as brown transparent balls, colourless after H.P.; cerium, as brown transparent balls, unaltered by H.P., &c.

Your readers will scarcely expect, nor you allow, all the details of these reactions to be entered into here; they can be ascertained by a reference to my little "Manual of Blowpipe Analysis," but I may mention here that the aluminium silicate is again separated by treating fresh powder in "pink P. acid P.P." (*i.e.*, in a bead of "glacial" phosphoric acid previously made pink by the solution in it, B.B., of a trace of cobalt oxide), when all but silica is dissolved; and over 5 per cent of alkali present in the mineral turns the pink bead blue.

I trust the above affords some idea of the *rationale* of one of my processes, and have only to add with reference to the analysis of *acmite* given that the fractions approximating to quantitative results there offered are, of course, based upon the actual proportions as ascertained by the published chemical analyses of the minerals examined; for, as there is no doubt whatever that constituents of minerals *are* separated as borates by treatment in boric acid before the blowpipe, it is only reasonable to assume that the borate representations (as balls, fragments, &c., which can be boiled out and weighed) bear a relative proportion to the quantity of basic oxides employed.

RESEARCHES ON RUBIDIUM AND CÆSIUM.

By M. C. SETTERBERG.

HAVING had to treat several hundredweights of alums obtained as secondary products in the extraction of lithia from lepidolites, the author has sought for a method of isolating from it the alums of cæsium and rubidium. Having found that the least-soluble alums are insoluble in a saturated solution of the most soluble alum, he has based upon this fact a method of extracting cæsium and rubidium.

Several hundredweights of crude alum are dissolved in such a quantity of water that the boiling solution may be of specific gravity 1·152. After the solution has settled it is let stand, drawn off into a second vat, and left to cystallise at the temperature of 45°. The alums of cæsium and rubidium crystallise totally, with an excess of potash alum. The crystalline deposit, added to other similar lots, is submitted again to a similar treatment which enriches it in cæsium and rubidium. This operation is repeated several times, decreasing the quantity of water, and letting the solution become colder. At the outset it is a saturated solution of potash alum, containing mere traces of cæsium and rubidium. The last crystallisation is free from potash alum, but its mother-liquor is not free from rubidium, and is consequently reserved for the treatment of a fresh lot of crude alum. The cæsium-alum is separated from rubidium-alum by the same method. Rubidium-alum is more soluble than cæsium-alum, the difference being greater at 80° than 0°.

To obtain from the alums other compounds of rubidium and cæsium, the author adds to the solution of the alums baryta in such quantity that all the aluminium sulphate is precipitated. The alkaline sulphate remaining in solution yields other salts by double decomposition.

To obtain metallic rubidium, the author calcines in a crucible 1500 grms. rubidium bitartrate with 150 grms. chalk and sugar. He then introduces the charred mass into an apparatus like that used in the preparation of potassium. The reduced metal is accompanied only by a small quantity of black matter. It is rectified—an operation attended with loss. It is better preserved in a sealed tube filled with hydrogen than under petroleum. This process does not succeed with cæsium. The author obtains this metal by the electrolysis of the melted cyanide. To obtain this cyanide in a pulverulent and not syrupy form, it is better to pass a current of dry hydrocyanic gas into a solution of cæsium hydrate into absolute alcohol. He then mixes 4 parts cæsium cyanide with 1 part barium cyanide. This mixture melts more readily than pure cæsium cyanide, and is easily electrolysed.

Metallic cæsium is of a silvery white, soft, easily oxidised, and it decomposes water like potassium. It melts at 26° to 27°, passing through a paste-like state. Its sp. gr. at 15° = 1·88.—*Bulletin de la Société Chimique de Paris.*

ON THE METALS OF CERITE.

By M. B. BRAUNER.

VARIOUS opinions have been given on the place occupied by lanthanum, cerium, and didymium in the periodic system of Mendelejeff. The author thinks that these metals occupy the eighth rank in the following groups with the atomic weights—

III.	IV.	III.-V.
La = 139	Ce = 141·6	Di = 147

If cerium is found in the fourth group, as Mendelejeff admits, it ought to yield a tetrafluoride, the existence of which compound is so far not established. Pure ceric hydrate, $Ce_2O_4+3H_2O$, if treated with a solution of hydrofluoric acid, furnishes a brownish amorphous powder of the composition CeF_4+H_2O. On heating this fluoride yields a gas analogous to chlorine, and capable of expelling iodine from potassium iodide.

On treating ceric hydrate with the hydrofluoride of potassium fluoride we obtain a white crystalline powder insoluble in water, the double cerium and potassium fluoride.

Didymium peroxide.—Mosander was aware of an oxide higher than the grey oxide (Di_2O_3), but its composition has escaped the notice of the chemists who have studied didymium (Marignac, Hermann, Zschiesche). MM. Frerichs and Smith obtained some years ago an oxide to which they assigned the formula Di_4O_9, a composition questioned by MM. Lothar Meyer and Clève. The author suggests that this peroxide contains Di_2O_5, which would place didymium among the tri- and pentatomic elements. MM. Clève and Nilson regard the peroxide as DiO_2.

In order to obtain a pure compound of didymium the author submits the sulphate to a series of crystallisations and of fractionated precipitations by oxalic acid. He then reproduces the sulphate, and then the chloride, until the latter gives the spectrum of pure didymium. The atomic weight of this pure didymium has been found = 146·58. The author, like M. Clève, has not succeeded in obtaining a peroxide according to the indications of MM. Frerichs and Smith. After many fruitless attempts to obtain didymium peroxide he has succeeded in preparing this body by adding to a mixture of didymium nitrate and hydrogen peroxide a dilute alkaline lye until a slightly alkaline reaction was obtained. A gelatinous precipitate was produced, greenish or reddish grey according to the depth of the stratum, and forming when dry a reddish powder. Its analysis led to the formula $Di_2O_5+3H_2O$, the same hydration as in case of $La_2O_3+3H_2O$ and $Ce_2O_4+3H_2O$. The author has obtained Di_2O_5 in the anhydrous state by carefully heating basic didymium nitrate to incipient redness in a current of oxygen. It is a porous mass of a

chocolate-brown colour, the density of which = 5·368 (the specific volume of $\frac{1}{2}Di_2O_5 = 34·8$). If heated to redness it loses the greater part of the oxygen over and above Di_2O_3, and the whole at bright redness. Hydrogen only reduces it at a dull red-heat, dilute nitric and sulphuric acids reduce it without escape of gas, and with concentrated acids it gives off ozonised oxygen. Hydrochloric in dissolving it produces only a little chlorine. It is insoluble in hydrochloric acid. It is ten times less soluble in ammonium nitrate than didymium sesquioxide, and twenty-nine times less than lanthanum sesquioxide. This circumstance, to a certain extent, allows of the separation of didymium and lanthanum.

The author has not been able to obtain either single or double salts corresponding to Di_2O_5, notwithstanding its solubility in dilute acids. On melting this oxide with potassium hydrofluoride there are obtained double fluorides corresponding to the sesquioxide.

The author has found the atomic weight of lanthanum = 138·9, agreeing with the determinations of M. Marignac and M. Clève.—*Bulletin de la Société Chimique de Paris.*

NEW METHOD OF DETECTING DYES ON YARNS AND TISSUES.

By JULES JOFFRE.

(Continued from page 212.)

Blue Colours.

The blues may be divided into two groups—those upon which potassa has little or no action, and those which it discharges or changes. The former group comprises logwood-blue, ultramarine, vat-blue, Coupier's blue, azurine, cyanine, and alizarine-blue or anthracene-blue.

Logwood-blue is detected by the action of hydrochloric acid, which turns it at once to a fine red. Potassa, without producing any great change, gives it a brownish tint. Ultramarine is decolourised by hydrochloric and nitric acids. Stannous chloride turns it black. It has, besides, a characteristic tone. Ultramarine is used only in printing, and hence care must be taken lest the dressing of the goods should prevent the reagents from exerting its action. The swatch should therefore he first washed with a little ether. This caution applies, indeed, to all colours fixed by printing.

Vat-blues are unaffected by hydrochloric acid, but nitric acid discharges them. In case of wool there remains a yellow colouration due to the action of the nitric acid upon the wool.

Coupier's-blue is but little affected by potassa, which turns it slightly greenish. It is not discharged by nitric acid, which distinguishes it from indigo, but its colour is changed to a dark reddish brown. Hydrochloric acid is without action. Azurine is unaffected by potassa. Hydrochloric acid turns it greenish, and nitric acid gives it a brownish cast, and ultimately decolourises it, but this change requires a long time, whilst a vat-blue is destroyed in an instant.

Cyanine is unaffected by potassa, but it is decolourised by hydrochloric acid, and a washing in water restores the blue. This reaction has some resemblance with that of the aniline blues, but the reagents are different. The latter are acted upon by potassa much as cyanine is by acids. Stannous chloride acts like hydrochloric acid.

Alizarine-blue is turned to a garnet-red or violet, and is discharged with a fine red colour. This reaction might cause it to be confounded with logwood-blue, though the latter is transformed into a lighter and brighter shade. Logwood-blue, however, becomes slightly brownish when treated with potassa, whilst alizarine-blue remains perfectly unaffected. Certain specimens, recently obtained by a new process, are not at all affected by acids.

The second group comprises extract of indigo, the Prussian blues, azuline, bleu de Lyon, and the "light" blue.

Extract of indigo leaves the cloth white after treatment with potassa and washing with water. Stannous chloride discharges the colour completely in a short time; ammonia has no action. The following is a characteristic reaction for the sulphuric compounds of indigo:—If the cloth is boiled with a weak solution of sodium carbonate it is decolourised, and the water becomes blue. This water, if acidified, will dye a small portion of wool blue.

Yarns or tissues dyed with a Prussian-blue become of a rusty yellow if treated with potassa. If then passed into an acid the blue colour is restored, but not by a prolonged washing in water. The presence of iron may be easily shown on incineration.

Azuline, bleu de Lyon, and light blue present the characteric reaction of the aniline colours; they are decolourised by potassa, or turned to a pale dirty violet; then, if washed in plenty of water, the original shade is restored in full brightness. Hydrochloric acid merely turns the blue slightly more greenish.

Green Colours.

The green dyes are divided into three groups according to their behaviour with potassa:—

1. The greens which it turns brown or yellow.
2. Those which are discharged, or at least become grey.
3. Those upon which potassa has no action.

The first group comprises sumac olive, and several compound greens, *i.e.*, *vert printemps* dyed with picric acid and extract of indigo, new-green dyed with picric acid and aniline-blue, and Saxony green dyed with turmeric and the sulphuric compounds of indigo. These four colours are distinguished thus:—

Sumac olive is turned brown by potassa, and ultimately light brown. Hydrochloric acid turns it grey, and stannous chloride a brown-grey.

Vert printemps is turned by potassa to a yellow or an orange. Ammonia and hydrochloric acid have no action. Stannous chloride produces no effect at first, but ultimately turns the cloth yellow; water does not restore the green colour.

New-green is likewise turned by potassa to a slightly brownish orange; ammonia turns it yellow; hydrochloric acid gives it a bluish cast, and stannous chloride has no decided action.

Saxony-green is turned a reddish brown by potassa. Ammonia and strong hydrochloric acid give it a brown colour. With stannous chloride it passes first to a dirty green, somewhat brownish, and ultimately to a fine orange-red.

The second group includes iodine-green, methylaniline-green, malachite green, and Schweinfurt-green. The following reactions distinguish these greens from each other and from other greens:—

Tissues dyed with any of the four first-mentioned are decolourised by potassa, but a prolonged washing restores the original colour. Still, if the shade is very light this restoration is difficult. Hydrochloric acid likewise discharges these dyes, and washing in water brings back the original shade. These discharges often leave a yellowish or brownish shade, especially if picric acid has been added, which is not uncommon. Ammonia likewise discharges them. Malachite-green is distinguished from iodine-green by its less blue shade. Schweinfurt-green is turned a greyish blue by potassa; hydrochloric acid turns it a yellow. Ammonia in excess develops the fine and peculiar blue colour of the oxide of copper in contact with excess of ammonia.

The third group includes the chrome greens, emeraldine, and dragon-green, composed of vat-blue and weld.

The chrome-greens are unaffected by all reagents. Chromium oxide may be detected in the ash of the tissue.

Emeraldine becomes of a blackish blue on treatment with potassa. Nitric acid turns it brown.

Dragon-green is unaffected by potassa, but nitric acid turns it to an orange-brown.

Yellows.

Many of these colours leave much uncertainty, being produced by vegetable colours which have a considerable analogy, and which contain the same accessory principles. They may be divided into four groups :—

1. Those which are turned by potassa to an orange or a red.
2. Those which potassa reddens more or less, and which are turned grey or blackish by ferric sulphate.
3. Those unaffected by potassa.
4. Those discharged by potassa.

The first group comprises turmeric, the yellow produced by the action of nitric acid, chrysoine, and chrome-yellow upon woollens.

These four yellows are respectively distinguished by the action of potassa. It turns the first red, the second brown (with decomposition of the fibre), the third to a fine red-orange, whilst the fourth, on long action, is blackened.

The second group includes quercitron, sumac, fustic, Persian berries, young fustic, barberry, and weld. All these dye-wares contain a notable proportion of tannin, the relative quantity of which may be estimated by the darker or lighter shade which the cloth takes when passed into ferric sulphate.

Quercitron and sumac contain the largest proportion of tannin, but sumac dyes only very light shades. Fustic contains less; berries and weld still less. Young fustic gives an orange-yellow. Barberry dyes light yellows, and is chiefly employed in dyeing leather.

The third group comprises annatto, saffron, aniline-yellow, Martius-yellow, and picric acid. Annatto and saffron are not affected by hydrochloric acid, whilst the three others are decolourised, though a plentiful washing in water restores the original yellow.

Annatto is distinguished from saffron by its more orange shade, and because if steeped in sulphuric acid (specific gravity 1·845) the shade become green.

Aniline-yellow verges slightly upon orange; Martius yellow is of a full yellow; picric acid a pale yellow. The last-mentioned is turned red if treated with a strong solution of potassium cyanide.

Aniline- and Martius-yellow may be found upon cotton, fixed by means of tannin, which may cause them to be mistaken for yellows of the second class. But the action of hydrochloric acid removes all doubt.

The fourth group contains merely chrome-yellow upon cotton, which is discharged by potassa and hydrochloric acid, and not restored by washing in water.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, November 25th, 1882.

Prof. Clifton, President, in the Chair.

A Paper by Mr. Wm. Ackroyd, "*On Rainbows produced by Light Reflected before entering the Raindrops*," was read by the Secretary. The author investigated mathematically the rare phenomenon of three bows, and inferred that it would generally take place about sunrise or sunset.

Mr. Lecky thought the effect had a simple explanation. It might be said to be due to two suns, one (reflected) appearing to be below the horizon.

Mr. Shelford Bidwell gave an account of some experiments he had made to test the theory of Dr. James Moser, that the action of a selenium cell under light was due to the heat rays making a closer microphonic contact between the selenium and the metal electrodes, by expanding the material. He submitted selenium cells to dark heat rays, and found their resistance to *rise*. Under light rays, however, their resistance fell. He therefore concluded that Dr. Moser's theory was erroneous, and that the fall in resistance due to the light rays is the differential result of the rise due to heat and the fall due to light. He also explained the "fatigue" of a selenium cell by use as caused by its increase of temperature. When the cell cooled again the fatigue disappeared.

Dr. Moser and Prof. G. C. Foster made remarks on this paper, the former suggesting experiments to test the reversibility of the effects observed by Mr. Bidwell, and the latter seeking to reconcile Dr. Moser's theory with the new data.

Dr. James Moser then read a paper "*On a General Method of Strengthening Telephonic Currents*." This consists in forming a primary circuit of the telephone transmitter in derived circuit, a set of induction bobbins in derived circuit, and a charged secondary battery, the whole circuit having a very low resistance. Each primary bobbin has a secondary wound over it, and these secondaries are connected "in quantity" to the telephone line, which has at its remote end a set of telephones in derived circuit to the earth or return wire. In this way one line wire serves to supply a large number of separate telephones, a hundred being employed by Dr. Moser to transmit music from the Hippodrome in Paris to the Place Vendôme. The system is applicable to long lines, and the induction noises are reduced by sub-division among the separate telephones.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, October 26, 1882.

Mr. John Pattinson in the Chair.

The Chairman—My duties this evening are very pleasant: to congratulate you on the commencement of another Session, and to invite our President-Elect, Mr. B. S. Proctor, to take the chair. I regret that Mr. Swan i unable to be present, but Mr. Dunn has just put into my hands a telegram from him in London, in which he says that he greatly regrets his absence from the meetin , but that he resigns the duties of President into the hands of Mr. Proctor with very great satisfaction, confident that the duties of the office will be discharged with ability, and that under his guidance the Society will have a year of exceptional prosperity. I have cordially to endorse what Mr. Swan has said, and beg to resign the chair in favour of Mr. Proctor.

The President (Mr. B. S. Proctor) then took the chair, and said—I have to thank you in the briefest possible manner for the honour you have done me in electing me your President. I will proceed at once to the ordinary business of the evening, and ask the Secretary to read the minutes.

The minutes of last meeting were then read and confimed.

The Treasurer then gave his financial statement.

The Secretary then read the Committee's report.

Committee's Report.

Your Committee have to report to this, the fifteenth annual meeting of the Society, that the number of members at present on the list is 155 against 152 at the same period of last year, showing a very slight increase.

The papers and notes read during the session have been as follows :—"Inaugural Address," by the President, Mr. J. W. Swan; "On the Variations in Composition of Steel Forgings," by Mr. T. W. Hogg; "On Voltaic

Accumulation," by Mr. Swan; "Experiments with Alloys of Lead, Copper, and Antimony, to ascertain their Fitness and Value in the Erection of Sulphuric Acid Chambers," by Mr. John Glover; "On the Albo-Carbon Light," by Mr. John Pattinson; "On the Determination of Arsenic in Copper," by Mr. John Pattinson; "Contributions to the History of the Oxides of Manganese." by Mr. J. T. Dunn; "A Lecture Experiment," by Mr. W. J. Grey; "On the Solubility of Sulphur Dioxide in Sulphuric Acid, by Mr. J. T. Dunn.

The financial condition of the Society is tolerably satisfactory. In place of a deficiency of £12 6s. 9d. at the commencement of last session there is now a balance of £7 4s. 8d. in the hands of the Treasurer.

The Society has this year suffered a severe loss in the death of two its past Presidents, Mr. R. C. Clapham, in December, and Prof. A Freire-Marreco, at the end of February. Both were actively instrumental in the foundation of the Society, and took throughout a lively interest in its welfare.

The difficulty of procuring papers has often been a subject which the Committe have had to notice. With a view to encourage research and the communication of its results amongst the members, Mr. Scholefield, in February, made the offer to the Society to found a prize or medal to be awarded each Session to the author of that paper which the Committee should think most deserving of it. A set of regulations concerning the award was drawn up by the Committee, and a circular embodying the substance of these was forwarded to each member in April last. The Committee trust that the members' appreciation of Mr. Scholefield's gift will show itself in an increased number of papers during the session.

As the members are aware, the Society of Chemical Industry extended an invitation to the members of this Society to attend their annual meeting at Manchester in July last. During that meeting the question of a possible amalgamation of the two Societies was informally discussed between some of the representatives of this Society and some of the officials of the Society of Chemical Industry. Since then an informal communication from Prof. Roscoe expressing the desire of the Council of that Society for such an amalgamation has been received by the Secretary, and the matter has been discussed in Committee. It was resolved to bring the matter before the members to-night, and to decide finally upon it at the December meeting.

Mr. Scholefield moved, and Mr. France seconded, the adoption of the balance-sheet and the Committee's report.

Mr. Morrison—I don't know whether I am out of order, but what makes the balance on the right side this year?

Mr. Pattinson—Perhaps the members have been looked after better; but it is principally due to the fact that the expense of the *Transactions* has been much less this year than last.

Mr. France—The chief matter in the report seems to be that of amalgamation, and it is one of such importance that I think steps should be taken to bring it before the whole of the members; and, in any circular which is issued, I think the advantages and disadvantages should be clearly set forth, because many of our members do not come to the meetings, as a rule, not from any lack of interest in the proceedings, but because such full and accurate reports of what takes place are given in the *Transactions*.

The President—I am very glad to hear Mr. France introduce this subject. It should be well debated in the Society: it has been well debated in Committee, and we are not all of one mind. It is a complicated question, and we should like much to hear the opinions of members outside the Committee on the suhject. Some report of this meeting will go forth in the *Transactions*, and it will thus be brought under the notice of members in time to enable them to form opinions on the subject for the next meeting.

Mr. John Pattinson—I was scarcely prepared to speak on this subject, though I have given it a good deal of attention, and it was, I believe. through myself that the matter was first broached. I was at a meeting in London where the Society of Chemical Industry was largely represented, and some of the officers asked me whether an amalgamation would not be practicable with this Society. I expressed no opinion at that time. Since then Mr. Dunn and I have had further informal communication with the members of the Council of the Society of Chemical Industry, at the meeting at Manchester, and in a correspondence which has ensued, it was agreed on their part that in the event of our Society joining in a body, the entrance fee of two guineas should be remitted, and only the annual subscription, one guinea, paid; while they would undertake the publication of our *Transactions*, and defray all local expenses for rooms, circulars, refreshments and so forth. I was very much impressed with the importance of that Society, and with the advantages which would accrue to us from amalgamation. They publish monthly, throughout the year, a very excellent journal, which contains, besides the proceedings of the annual and sectional meetings of the Society, abstracts of papers in other journals, and notes and communications from all sources on subjects related to applied chemistry. Besides the annual meetings, the Society divides itself into sections (of which they intend to have twelve, and are very wishful to form one here), each of which holds its own meetings, and is practically as independent as if it were an in ividual society.

The President—The Committee have been very much exercised as to the effect which the proposed amalgamation would be likely to have on the award of the Scholefield Medal. Under these circumstances we naturally feel that Mr. Scholefield's views on the subject should have some weight with us, and I should be glad if he would state them to the meeting.

Mr. Scholefield—I think there is a good deal to be said both for and against the amalgamation. Mr. Pattinson has very fairly stated the case for the advantages. On the other hand, I think we should lose our identity; lose a great deal of interest which we now feel in our Society. The increased subscription will decrease the number of our members very much; the young men connected with our chemical works will be very likely to resign, and my object last year was directed to the encouragement of that particular class. The reports being published in the *Journal of the Society of Chemical Industry* will tend to decrease our interest. The information contained in their *Journal*, too, can be obtained without a fusion of the two societies; many of our members are already members of the other society—I am for one—and they, I am sure, would be willing to lend their copies of the *Journal* to those who are not, and who are wishful to read them. It has been suggested that those members who live at a distance will withdraw if amalgamation does not take place, and will not continue members of both societies. This is a matter of opinion. I have heard it stated by one of those members that it would have a contrary effect with him: that if we remain separate he could read the same paper at both societies. I am not prepared to say that I decidedly oppose the amalgamation; I only press for the postponement of our decision on the matter, so that in the meantime we may have it thoroughly discussed and considered. I think we should make a considerable sacrifice if we joined it, and I should like to see how we work separately for another year.

The President—The report of this meeting will go out to the members, and we propose to have the subject fully discussed at the November meeting, and that then a voting paper should be sent to the members, and the matter finally settled in December.

The adoption of the balance sheet and the Committee's report was then carried.

The name of Mr. A. M. Lytle, North of Ireland Chemical Company, Belfast, was read for the first time.

Mr. B. S. Proctor then delivered the following—

Inaugural Address.

The most important function of the President of a Chemical Society is to stimulate the chemical activity of the members by an action parallel to catalysis.

By his own molecular activity he should bring into play the affinities which are capable of developing new matter, without himself entering into combination with other molecules, in such a way as to deprive them of their individuality.

This function of your leading officer is much more easily exercised when his habitual work is intimately associated, either practically or theoretically, with the daily occupations of the members in general.

Unfortunately this is less the case with me than with any of the gentlemen who have filled this office before me. On this account I shall have to claim a large share of your indulgence and assistance.

Looking back a year, our Society has lost two of its most eminent members, one distinguished for his extensive acquaintance with the chemical resources of the district, and the readiness with which he became the exponent and historian of its technology. The other, pursuing the paths of pure science, occupied a position of vantage not practically within the reach of technical chemists—a position which enabled him to meet each of us as an equal on our own ground.

It will be impossible for me to interest you as the former would have done by reviewing the technical changes of the past, and the prospects of the future for chemical manufacturers, or to trace the development of chemical laws, and recount the discoveries of recent years as would have been an easy task to the latter; but as every man's experience, and every man's train of thought, has necessarily something of individuality to distinguish it from that of his fellows, and as each may profit to some extent by noting the facts or the fancies of his fellows, I will endeavour to lead you as it were on a holiday excursion, away from the technical department of our studies, where everything turns on the pivot of cost, and away from the purely scientific side, where all is excluded but experimental investigation and mathematical law.

I desire for the present to get beyond the walls of the shop and the boundaries of the college. I desire to feel the freedom in which the schoolboy rejoices who has escaped from the customary restraint. I wish to be at liberty to say things which may be fanciful or imaginative, but I trust not foolish. Fancy has its duties in philosophy, though not in science. Fancy develops a multitude of half-truths, which by the treatment of science are decomposed, evolving an atom of truth and eliminating an atom of error—so truth is established, which would have lain dormant had not fancy thrown down the gauntlet to science. Our speculations are evolved by the philosophical use of the imagination, from the unsystematised truths which may be regarded as the waste-material of science. Professor Mills says—"The roadway on which chemistry now runs has been elevated by the rubbish of at least 2000 years."* It is my ambition now to scrape together a little heap of such rubbish.

It seems to be the natural desire of a chemist to see with his mind's eye the atoms and molecules, which can no more be seen through the microscope than by the unaided eye. While endeavouring thus to see the constitution of matter, we are told on the one hand that we may relieve ourselves from the idea of matter altogether, and be content with resolving all things into force;† and, on the other hand, we are told that force, in all its many manifestations, may be resolved into matter and motion. We are told at one time that force cannot act at a distance, that attractions are all resolvable into the effects of impacts of molecules in motion; and at another we are told that the molecules of solid bodies do not touch one another, the space occupied by the actual matter being small compared with the space separating the atoms from one another. We are told that attraction, as hitherto understood, is irrational because it is inconceivable. It is pointed to as an absurdity that force should throw out its boat-hooks and draw two masses of matter together. To my mind the conception of a repelling force is just as difficult as an attracting, and I am compelled to admit that, where both are inconceivable, there is not much to determine us in rejecting one if we cannot equally do without the other. But we may dismiss them both, repulsion most simply by supposing it to result from the rebounding of atoms in collision; and we get rid of the idea of attraction by a speculation just one step more complicated, in supposing it to be caused by the collisions of atoms preponderating in one direction, the attracting bodies shielding one another on one side, and so being forced together by the impact of atoms on the opposite sides; but for these speculations to be entertained we have to assume that atoms can pass through masses with nearly perfect freedom, which does not accord with our usual ideas of matter. To help us in our craving for an explanation of everything, the existence of a luminiferous ether is assumed, and it is endowed with hypothetical properties to suit every difficulty. It is assigned a position intermediate between matter and force. It is supposed to fill all space and penetrate all bodies. It is supposed to be the basis—the physical basis perhaps we might say,—of heat, light, electricity, magnetism, &c. Its movements are supposed to be the cause of polarity and induction. Perhaps they *are*, if the ether has any existence. On the present occasion, as I have stipulated for a full play of the imagination, we will assume the existence of the ether, the existence of matter, of atoms, of molecules, of spaces between them, of repulsions, attractions, polarities, molecular movements, and whatever else the exigencies of the moment demand.

The middle-aged chemist of the present day was taught in his youth that the general properties of matter included ponderability, size, shape, &c. That matter was distinguished from immaterial forces by its ponderability, the forces being spoken of as imponderable agents, though the expressions were often used somewhat indefinitely.

Gmelin ("Handbook," p. 2) speaks of the imponderables as *bodies*. Miller, without making the statement in so many words, evidently assumes that "bodies" or matter must be possessed of weight ("Elements of Chemistry," 1855). In looking over these and other books which I reverenced as unquestionable authorities, quarter of a century ago, I feel tempted to put marginal queries to many paragraphs which point to questionable conclusions.

I propose to take as my starting-point two or three of these marked passages—passages which will probably retain their position and authority for many years to come, but which nevertheless do not harmonise with more recent experience or modes of thought.

Turning to Miller's "Elements" (Vol. i., page 65), the phenomena of solution are explained as the result of the adhesion of the solvent to the solved, overcoming the cohesion of the latter. This can scarcely be regarded as an explanation, but even if viewed simply as a statement it is far from being satisfactory. If we accept the common meaning of the word adhesion, that is "sticking to," it can scarcely be admitted that a liquid sticking to a solid explains its disintegration. Nor is it much more satisfactory as an explanation, though it may be more correct as a statement, to say that the force which commonly manifests itself as cohesion is overcome by another force which commonly manifests itself as adhesion. Cohesion and adhesion may fairly be regarded as effects or manifestations of some form of force, but in a critical enquiry it is necessary to avoid confusion between a force itself and the phenomena by which that force is made manifest. It is scarcely a philosophical statement to say that a pow-

* *Phil. Mag.*, January, 1876.
† *E.g.*, Sir W. G. Armstrong, British Association Address, 1863, &c.

dered substance dissolves more quickly "from the partial destruction of cohesion." Nor can we very readily admit that there is less adhesion between a crystal of sugar and a saturated syrup than between the same crystal and water. How then can we say that solution of the crystal takes place in consequence of the force of adhesion between it and the water in which it is immersed, and remains unacted on by the syrup from the absence of adhesion between a material and its saturated solution?

When a supersaturated solution deposits a crystal, the cohesion is said to overcome the adhesion acting between the solvent and the substance of the crystal, but it can scarcely be admitted that cohesion proper comes into existence till the separation has taken place, though it might be correct to say that the *force which causes cohesion* has caused the separation of the solid from its solvent.

This would naturally lead to the question—"What is the nature of the force which causes cohesion?"

Gmelin ("Handbook," I., 38) says, "If the insolubility of crystallised alumina arose from its adhesion being greater than its affinity for the acid, it ought not to dissolve in the acid after being ignited with potash, but to separate in consequence of its greater cohesion after the potash had been dissolved in the acid." In such a case as this I should say the cohesion of alumina no longer existed. It had been destroyed by the potash; not that any matter nor any force had been destroyed, but that one effect of a force had been destroyed by the diversion of the force to the production of another effect.

(To be continued.)

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 19, November 6, 1882.

Comparative Observation of the Telluric and Metallic Rays as a Means of Estimating the Absorbent Powers of the Atmosphere.—A. Cornu.—This important memoir does not admit of useful abstraction.

Result of Experiments made at the Electrical Exhibition on Machines and Regulators with Alternating Currents.—MM. Allard, Le Blanc, Joubert, Potier, and Tresca.—These experiments refer merely to three systems of electric lighting in which machines with alternating currents are employed with the arc. The results are given in a tabular form.

Process for the Separation of Sulphur from its Gangue.—MM. de la Tour and Du Breuil give a communication on their process for the extraction of sulphur by means of a bath of a temperature higher than its point of fusion. The process has been applied with success to the *sterri* of Sicily, that is, the pulverulent and rich débris, produced by the manipulation of the ore. This refuse cannot be treated in the *calcaroni*, and has accumulated in great quantities. The use of the new apparatus has given a yield of 30 to 70 per cent of merchantable sulphur, —a return superior to that of the best ores treated by the old process.

Relation between the Electromotor Force of a Dynamo-Electric Machine and its Speed of Rotation.—Maurice Levy.—Not suitable for abstraction.

Comparison of the Mercurial Thermometer with the Hydrogen Thermometer.—J. M. Crafts.—The author shows that it is not sufficient to class the thermometers of our laboratories in two categories, according to the presence or absence of lead oxide in the glass, applying to the one the corrections given for the crystal of Choisy-le-Roi, and to the other those for common glass. Instead of plunging thermometers for comparison into an oil-bath he recommends that they should be heated by the vapours of pure and inalterable substances, such as naphthaline and benzo-phenon.

A Hydrate of Molybdic Acid.—F. Parmentier.—The author has examined the deposit which gradually forms in bottles of the ordinary ammonium molybdate solution as used for the separation of phosphoric acid. The author represents the composition by the formula $MoO_3,2HO$.

Transformation of the Blood of Animals into a Solid Inodorous Manure by a New Ferric Sulphate.—P. Marguerite-Delacharlonny.—The author effects the coagulation of the blood by treatment with an acid ferric sulphate of the composition $Fe_2O_34SO_3$. This salt takes up 12 molecules of water in order to form a crystalline hydrate, and in this manner it solidifies blood.

Passage of Alcoholic Liquids through Porous Bodies.—H. Gal.—Without denying the particular influence of the reciprocal action of a membrane and of a liquid with which it is in contact, the author thinks that this influence is subordinate to conditions of equilibrium with the external medium. If the nature of the liquid and that of the diaphragm play one part, one not less important must be ascribed to the temperature and the hygrometric state of the ambient air. The phenomenon is further complicated by the action of the mass and by the tension of the vapours present. The alcoholic liquid increases or decreases in concentration according as the vapours which it gives off find themselves, on issuing from the membrane in presence of an infinite mass of moist or of dry air. We may even conceive an assemblage of conditions in which the degree of concentration would remain constant, confirming the remarkable analogy demonstrated by H. Sainte-Claire Deville between the phenomena of evaporation and those of dissociation.

Reduction of Sulphates by Living Beings.—A. Etard and L. Oliver.—In this preliminary communication the authors show that certain algæ of the genus *Beggiatoa* and other allied groups have the power of reducing sulphates in solution.

An Allylic Mono-chloric Alcohol and its Derivatives.—L. Henry.—The author has obtained and examined the compound $\alpha CH_2=CCl-CH_2(OH)$. He prepares it by boiling in a flask with a reflux condenser epibichlorhydrine with a dilute solution of potassa. After boiling for some hours the whole is distilled, when the mono-chloric allylic alcohol passes over in the first portions, and may be totally freed from water by the addition of potassium carbonate. It is a colourless limpid fluid, less mobile than allylic alcohol. Its sp. gr. at 19° = 1·164, and it boils without change at 136°.

Chemical Studies on the Sugar Beet.—H. Leplay. The exhaustion of the soil is greater and the saccharine richness of the beets decreases in proportion as they take a greater development in volume or in weight. The method of diminishing the exhaustion of the soil is to plant the beets closer together, thus multiplying the points of contact between the soil and the roots.

Reduction of Nitrates in Arable Soil.—MM. Dehérain and Maquenne.—It appears probable that the reducing agent which effects the decomposition of nitrates in soil is *Bacillus amylobacter*.

Direct Fermentation of Starch: Mechanism of this Metamorphosis.—V. Marcano.—This transformation is effected by the action of a microbion on the grains of starch. Diastase cannot act usefully on the stratified granulose unless the layers are ruptured at some point. This is in the first place the function of the microbion.

Disinfecting and Antiseptic Action of Copper.—M. Burcq.—The author shows that workers in copper,

bronze, &c., enjoy a practical immunity against cholera, typhoid fever, &c.

Justus Liebig's Annalen der Chemie,
Band 214, Heft 3.

Action of Phosphorus Penta-chloride upon the Amides of Acids (Second Treatise).—O. Wallach.—In this memoir the author discusses at great length the behaviour of the amides of oxalic acid, the oxalines, oxal-ethyline and its derivatives, the products of the action of bromine upon chlor-oxal-ethyline, the action of water and of acids upon chlor-oxal-ethylene at elevated temperatures, the behaviour of chlor-oxal-ethyline on oxidation, its distillation over lime, di-oxal-ethyline, oxal-ethyline, its distillation over lime, oxal-methyline, oxal-propyline, chlor-oxal-amyline, propyl-glyoxaline, and amyl-glyoxaline. The memoir concludes with considerations on the constitution of the oxalines.

Azaurolic Acids, a Series of Nitrogenous Fatty Bodies.—Victor Meyer and E. J. Constam.—The authors have obtained the first member of the series ethyl azaurolic acid and its next higher homologue, propyl-azaurolic acid. They have not succeeded in preparing methyl-azaurolic acid in a state of purity, though proofs of its existence have been obtained. The material for the preparation of ethyl-azaurolic acid is ethyl-nitrolic acid, obtained from commercial nitro-ethan. 2 grms. of ethyl-nitrolic acid were suspended in 10 c.c. water in a small beaker, placed in a freezing mixture of salt and ice, and 40 grms. of 5 per cent sodium amalgam were gradually added amidst constant stirring. The amalgam, which quickly disappears, occasions a development of heat, but the temperature of the liquid must rise but little above 0°, and should not fall appreciably lower. The intense blood-red liquid is decanted from the mercury and cautiously acidified with sulphuric acid, avoiding a rise of temperature. Fine entangled yellow needles are formed, which are drained from the mother-liquor upon a vacuum filter, and the acid, mixed with crystals of sodium sulphate, is dried over sulphuric acid along with the filter. The acid is purified by repeated crystallisation from boiling alcohol, and appears in shining prisms of a fiery orange-red. Its silver salt is brown, and its zinc and lead salts are yellow. The acid is readily soluble in hot alcohol, but sparingly in ether and water. In ligroine, chloroform, and benzol it is almost insoluble. In alkalies it dissolves with an intense orange-red colour. It is decomposed by treatment with excess of concentrated ammonia, as also by boiling with dilute sulphuric or hydrochloric acid, yielding a highly characteristic colourless substance, which the authors name ethyl-leukazon. The composition of ethyl-azaurolic acid is $C_2H_4N_2O$.

Chloride of Lime and Chloride of Lithia.—K. Kraut.—The conclusions reached by the author are that the formula Cl.Ca.O.Cl, expresses the empirical composition of chloride of lime inaccurately; that the formation of bleaching chlorine compounds by the action of chlorine upon solid hydrated oxides is not limited to the presence of a polyvalent metal; and that the decomposition of chloride of lime by carbonic acid is not explained by Odling's formula, but by the action of carbonic acid upon hypochlorites, and by that of hypochlorous acid upon calcium chloride in presence of carbonic acid.

Behaviour of Lupinine with Dehydrating Agents.—G. Baumert.—The author examines the behaviour of lupinine with phosphoric anhydride and with hydrochloric acid at elevated temperatures and under pressure. The former reaction yields liquid bases, which quickly turn brown on exposure to the air. Fuming hydrochloric acid, up to a temperature of 200°, does not split off methyl groups, but successively 1 and 2 mols. H_2O, yielding anhydro-lupinine and dianhydro-lupinine. Metallic sodium has no dehydrating action upon lupinine, but yields a substitution-product behaving analogously to the alcoholate compounds.

Deutsch-Amerikanische Apotheker Zeitung.
Vol. iii., No. 13, September 15, 1882.

Glucose and its Applications.—A notice of the purposes,—mostly fraudulent,—to which glucose is applied.

Communications from the East.—Dr. X. Landerer.—The author states that in Greece immense quantities of raisins and currants are allowed to spoil for want of proper appliances for drying. The value of the olive oil available for exportation is estimated at 200 million francs. The phylloxera has not yet made its appearance. Millions of lemons are wasted yearly in the Island of Poros, but a manufactory of citric acid which was there established failed because the ignorant managers evaporated the juice over an open fire, and converted the acid into a worthless pyro-product.

Galaktine.—This compound, extracted from the seeds of lucerne, is a well-defined chemical individual.

Pharmaceutical Notices.—Under this head follow a number of paragraphs which have no especial interest for our readers.

The Thirtieth Meeting of the American Pharmaceutical Association.—We find here nothing of importance.

Chemical Notes: Preparation of Chlorine from Chloride of Lime.—M. Clossen.—The author proposes to use, instead of the relatively costly "hydrochloric acid," waste-products, such as manganese chloride, ferric chloride, alumina, calcium carbonate, &c., all of which liberate chlorine from chloride of lime.

Improvements in the Electrolytic Precipitation of Metals.—In order to obtain metallic deposits, compact, and capable of taking a polish, the solution of the metal in question is converted into a double potassium oxalate by the addition of neutral potassium oxalate, ammonium oxalate is added in excess and a little sodium carbonate, and the metal is thrown down by connecting the object to be coated with the zinc pole of the battery and plunging it into the solution. The other pole of the battery is connected with a plate of platinum.

Bulletin de la Société Chimique de Paris.
No. 3, August 5, 1882.

Limits of Electrolysis.—M. Berthelot.—Already noticed.

Decomposition of Metallic Formiates in Presence of Water: Production of Certain Crystalline Mineral Species.—J. Riban.—A lengthy memoir, which does not admit of useful abstraction.

Action of Alkaline Hypochlorites upon Phenol.—T. Chandelon.—The author obtains trichloro-phenol and compares its properties with those of the trichloro-phenol produced by the action of gaseous chlorine.

Action of Bromine upon Quinoleine and Pyridine.—E. Grimaux.—The author has studied the bromine addition-products of these bodies with the view of comparing them with the bromine derivatives of cinchonine.

The Action of Sulphuric Acid upon Thialdine.—L. J. Erikson.—It results from the author's experiments that thialdine is a secondary base.

Choloidanic Acid.—P. T. Clève.—The author has obtained and examined the cholanic, choloidanic, and pseudo-choloidanic acid, and certain of their derivatives.

Russian Chemical Society.—Session of October 8/20, 1881.—M. Orlowsky gave a communication on the affinities of sulphur and selenium for the metals.

The same chemist proposes the following method for detecting cadmium in presence of copper: The blue solution obtained after the separation of bismuth hydrate is acidified with hydrochloric acid, stannous chloride is added until the liquid becomes colourless, amorphous soluble sulphur is added, and the whole is heated to a boil. All

the copper is thrown down as a black sulphide. Ammonia is added to the filtrate to precipitate the hydrates of tin and cadmium, but the latter re-dissolves in an excess of the reagent. If ammonium sulphide is added to this solution the presence of cadmium is shown by a yellow precipitate. Another process, already indicated by Vortmann, is based on the action of sodium hyposulphite upon the cupric salts.

M. Saytzeff read a paper on the transformation of butyric lactone into normal butyric acid.

M. Miller has obtained dibromated naphtho-quinone by causing bromine in presence of iodine to act upon naphtho-quinone dissolved in acetic acid.

M. Pawloff exhibited Orlowsky's apparatus for preparing chlorine.

M. Sokoloff, in transforming mannite into nitro-compounds by the action of concentrated nitric and sulphuric acids, obtains, besides hexa-nitro-mannite, a quantity of a lower nitro-compound. M. Sokoloff announces that when nitric and sulphuric acids act upon lactose, there is formed, besides the known crystalline ether, another ether which is gummy.

M. Wilm announces that pure palladium cannot be obtained by precipitation as a cyanide.

M. Mendelejeff pointed out that among the numerous new metals recently discovered in gadolinite and cerite, only two are distinctly established, scandium and ytterbium.

Nos. 4 and 5, September 5, 1882.

Reciprocal Solutions of Liquids.—Wladimir Alexeew.—The author finds that the reciprocal solubility of liquids is not as simple as the hypothesis of Dossios would require. For certain compounds, such as isobutylic alcohol, the solubility, instead of increasing, diminishes with a rise of temperature. The solubility decreases up to a certain limit, beyond which it increases again as the temperature rises; in other words there exists a minimum of solubility, just as for certain solids there is a maximum of solubility. These two phenomena may have analogous causes, and may be due to the formation of unstable chemical compounds. Certain bodies generally considered as solids may form with water two kinds of solutions. Thus phenol and water if placed in contact form two layers: the lower is a solution of phenol in water, and the upper a solution of water in phenol. The solubility of these liquids in each other increases with the temperature, and at a certain limit (83° for a phenol melting at 36°; 68° for a pure phenol) they melt in all proportions. Many liquids follow the same law, *e.g.*, aniline and water. It appears from the author's researches on the reciprocal solubility of phenol and water, aniline and water, &c., that there is no essential difference between the laws presented by liquids and by solids.

Nascent Hydrogen.—D. Tommasi.—The author shows experimentally that the properties of nascent hydrogen are not inherent in this allotropic state of the gas, but that its reducing power varies according to the chemical reaction by which it has been produced. Its heightened affinity at the moment when it is liberated from a compound depends merely on the fact that it is accompanied by all the heat produced when it is liberated. Hence nascent hydrogen is a synonym for hydrogen + calories.

Researches on the Ferric Hydrates.—D. Tommasi.—All the ferric hydrates appear divisible into two series, the red, α, and the yellow, β. The former are obtained on precipitating a ferric salt with potassa, soda, or ammonia. The β series are obtained by oxidising ferrous hydrate, magnetic hydrate, or ferrous carbonate. Series α readily dissolve even in the weakest acids, and present the phenomenon of incandescence on ignition. Series β are sparingly soluble in acids, either dilute or concentrated, and do not present the phenomenon of incandescence. Ferric chloride dissolves the series α in great quantity, but does not dissolve the series β.

Sulphur Compounds of Silicium.—Paul Sabatier.—The author has obtained a brown body which is either a mixture of SiS_2 and of amorphous silicon, or of SiS_2 and of a sub-sulphide. He has produced, also, SiS_2 in fine white needles, and a yellow pulverulent matter, which is probably a mixture of the ordinary sulphide and the sub-sulphide.

Aluminium Sulphate Free from Lead obtained from Bauxite.—C. Fahlberg.—The author's process consists in the preparation of plumbic peroxide, in its application to the treatment of the solution of aluminium sulphate, and in the generation of the plumbic peroxide. To prepare lead peroxide, 200 parts litharge and 100 parts common salt are ground together in a mill till the mass takes the white colour of lead peroxide. The product is then boiled with a clear solution of chloride of lime till it takes a uniformly brown colour, when it is washed and kept moist for use. To prepare an aluminium sulphate free from iron by means of sulphuric acid and bauxite, or any other aluminous mineral, the solution must be neutral or slightly alkaline, as lead peroxide does not entirely eliminate the iron from acid solutions. For 1 part of iron contained in the solution it is necessary to use 20 parts of PbO_2 (calculated as dry). The peroxide paste is added cold to the solutions, stirring continually, and avoiding a rise of temperature. The solutions should not be too concentrated, especially if the sulphate of alumina contains more than 10 per cent of iron. Care must be taken that all the iron is in the state of a ferric salt. To regenerate the lead peroxide the deposit is filtered in the filter-press, the solid matters are suspended in water, and treated with dilute nitric or sulphuric acid untouched. The author has applied lead peroxide to the analytical separation of other metals from iron.

Decomposition of Certain Metallic Acetates in Presence of Water: Production of Crystalline Mineral Species.—J. Riban.—Not adapted for abstraction.

Action of Potassium Carbonate upon Benzyl Chloride and Benzylene Chloride.—J. Meunier.—The author has successfully applied the reaction of Cannizaro to the preparation of benzylic alcohol.

Indophenol and Kœchlin's Fast Violet.—A. Pabst.—This paper will be inserted in full.

Determination of Potash in Manures.—Edmond Dreyfuss.—This memoir will appear at length.

Russian Chemical Society.—Session of Nov. 12/24, 1881.—M. Alexéeff has modified the picnometer of M. Mendelejeff, rendering it more simple, more easy to clean, as well as better adapted for determining specific gravities between very wide limits of temperature. The vertical position given to the instrument is a great improvement.

M. Alexéeff likewise communicated the continuation of his researches on the mutual dissolution of liquids.

M. Rizza announces that on causing 2 mols. of chloral to react upon 5 mols. of zinc-methyl there is obtained dimethyl-iso-propyl-carbinol and not pinacolic alcohol.

M. Flavitzky sent in a communication on the relations existing between the rotatory powers of certain substances and of their active derivatives.

M. Lubavine presented a hypothesis on the various bodies pertaining to the indigo group, the basis of which is indol. He considers indigo an oxide analogous to allylene oxide.

M. Lipp treats of valeridine regarded as a diamylamine.

MM. Markownikoff and Oglobine have prepared, with the different fractions of petroleum hydrocarbons, boiling between 180° and 280°, an entire series of sulphones.

MM. Beilstein and Wigand obtain mesityle by boiling acetone with acetyle chloride.

M. Wilm indicates a new method for separating and purifying palladium. The filtrate obtained on precipitating platinum as ammonium chloro-platinate is heated with an excess of ammonia. The filtered solution, of a

deep blue colour, contains much copper, and on treatment with hydrochloric acid it deposits a yellow residue, containing according to the relative quantity of the other metals of the platinum group, the palladium salt $PdCl_2,2NH_3$ either almost pure or a mixture of that salt with a compound of rhodium $RCl_3 5NH_3$, in which latter case the residue is of a dirty yellow colour. The palladium salt, if precipitated from an ammoniacal solution a second time by hydrochloric acid, is absolutely pure.

M. Louguinine proposes certain modifications relative to the analysis of organic substances.

M. Mendelejeff expressed the opinion that the persulphuric acid of M. Berthelot presents in its reactions and properties the character of true peroxides, such as those of hydrogen, barinm, and sodium. It even combines with H_2O_2. It is not properly an acid, since it can neither combine with bases nor form salts. He regards it as sulphur peroxides. There is no reason to suppose that hydrogen, barium, &c., can form acids by combining with a larger proportion of oxygen.

Session, Dec. 3/15, 1881.—

M. Sokoloff laid before the Society a new eudiometer.

MM. Markownikoff and Oglobine communicated a second preliminary notice on the petroleum of the Caucasus.

M. Kissel gave in a communication on the action of aeid organic chlorides upon the sodium derivative of nitrethane.

M. Goldstein presented a memoir on the boiling-points of the saturated hydrocarbons of abnormal structure.

M. Tschirikoff proposes the use of palladium for the absorption of the hydrogen evolved in certain reactions in sealed tubes, and even for the quantitative determination of this gas.

M. Diaconoff has determined the specific heats and the evaporation heats of normal propylic alcohol, amylic alcohol (of fermentation), and di-methyl-ethyl-carbinol.

M. Louguinine's method of illuminating thermometers used in calorimetric researches consists in placing by the side of the thermometer Geissler tubes of uranium glass filled with a fluorescent liquid (solution of quinine sulphate or fluoresceine). He thus obtains sufficient light without fear of the disturbing influence due to thermic radiation from ordinary sources of light.

M. Diaconoff exhibited two tubes, acting as aspirating-pumps even at a very small pressure of water, and useful for filtration and for washing precipitates.

M. Zaboudsky made a communication on the carbon hydrate formed at the expense of the combined carbon in cast-iron, and on the determination of this carbon in cast-metal, iron, and steel.

Chemiker Zeitung.
Vol. vi., No. 50, August 31, 1882.

The Municipal Chemical Laboratory in Paris.—A description of a laboratory for the examination of articles of food, drink, medicine, &c.

Albo-carbon Burners.—F. Rüdorff.—The flame is said to give a steady white light, well suited for shops. It is less adapted for dwelling-rooms and work-tables, as the flame has to burn for thirty minutes before becoming serviceable. It is not applicable for street-lighting, as it is very sensitive to currents of air, which cause it to burn with a smoky flame.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Tannate of Soda.—Would some of your able contributors kindly give me the formula for the substance known as "Tannate of Soda," with a brief description of its properties, and its effect when added to waters containing carbonates and sulphates of lime and magnesia, also the reactions which would be likely to take place?—G. WRIGLEY.

MEETINGS FOR THE WEEK.

MONDAY, Dec. 4th.—Medical, 8.30.
—— London Institution, 5.
—— Royal Institution, 5. General Monthly Meeting.
—— Society of Chemical Industry, 8. "Incrustations in Boilers, and Purification of Water," by Mr. W. J. Macadam.
TUESDAY, 5th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
WEDNESDAY, 6th.—Society of Arts, 8. "The Artificial Drying of Crops," by William A. Gibbs.
—— Geological, 8.
—— Pharmaceutical, 8.
THURSDAY, 7th.—Chemical, 8. Ballot for the election of Fellows. "On the Condensation-Product of Phenanthraquinone with Ethylic Aceto-acetate," by F. R. Japp and F. W. Streatfield. "On the Condensation-Products of Œnanthol, Part I.," by W. H. Perkin, junr. "On the Condensation-Products of Isobutyl-aldehyd obtained by means of Alcoholic Potash," by W. H. Perkin, junr. "On the Formula of Lophin," by H. E. Armstrong. "On the Molecular Weight of Basic Ferric Sulphate," by S. U. Pickering. "On certain Brominated Compounds obtained in the Manufacture of Bromine," by S. Dyson. "The Chemistry of Hay and Ensilage," by F. Woodland Toms. "Note on the Preparation of Diphenyleneketone Oxide," by W. H. Perkin.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
—— London Institution, 7.
FRIDAY, 8th.—Quekett Club, 8.
—— Astronomical, 8.

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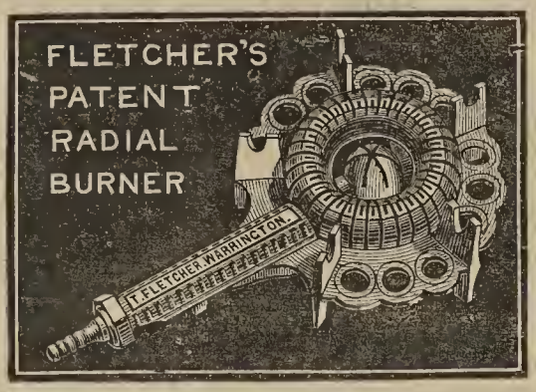

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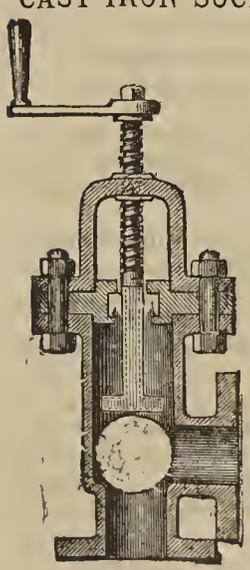

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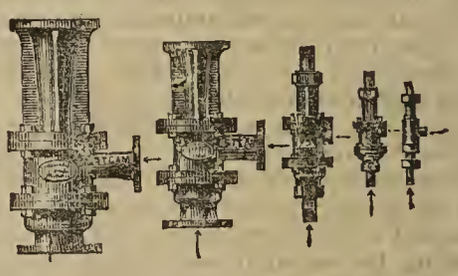

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THE CHEMICAL NEWS.

Vol. XLVI. No. 1202.

ON THE LECLANCHÉ CELL, AND THE REACTIONS OF MANGANESE OXIDES WITH AMMONIUM CHLORIDE.

By EDWARD DIVERS, M.D.,
Principal of the Japanese Imperial College of Engineering.

The occurrence of my name as a misprint for Davis, in an abstract in the July number of the *Journal of the Chemical Society*, of Longi's paper, on the Leclanché cell crystals, makes me desirous to publish that I have never written a communication on this subject. Somewhat oddly it happens, however, that I did work at it some years ago, with the assistance of one of my pupils, Mr. M. Kawakita, and as there seems to be nowhere a very satisfactory statement of the chemistry of this cell, I take this opportunity to publish what I hold to be a more exact account than has yet appeared, based upon experiments in only a few points absolutely new perhaps, but still proving facts apparently little known or considered. Some of these experiments have only just been made. I will first state the action of zinc and of manganese oxides separately upon ammonium chloride solution, and then their combined action upon it.

Zinc is slowly acted upon by a solution of ammonium chloride, hydrogen gas being evolved, and a zinc compound appearing in the solution. The solution acquires an alkaline reaction, and an almost imperceptible odour of ammonia. The nature of the substances reacting, the properties of zinco-di-ammonium chloride, and the gradual separation of this salt in crystals in a Leclanché cell, leave no doubt that the zinc compound going into solution is zinco-di-ammonium chloride in combination with ammonium chloride. But because Longi has found crystals in a Leclanché cell which proved to be slightly impure ammonium chloride (a common experience, the crystals forming merely in consequence of the evaporation of the water), he appears unreasonably to doubt Priwoznik's statement, that $Zn(NH_3Cl)_2$, zinco-di-ammonium chloride crystals, are formed in the normal working of the cell. I therefore mention that Mr. Kawakita found in these crystals nothing but ammonia, chlorine, and 38·6 per cent of zinc, the calculated quantity being 38·23 per cent. The properties of this salt, the knowledge of which bears upon the explanation of the Leclanché cell, are that it is sparingly soluble in ammonium chloride solution, rendering it alkaline, but only faintly ammoniacal. Its solution is not decomposed by dilution with water. It must be regarded as going into solution as double chloride of ammonium and zinco-di-ammonium, $(ClH_4N)_2{\cdot}Zn(NH_3Cl)_2$. On heating the solution much ammonia escapes, with most probably the formation of double chloride of zinc and ammonium, thus,—

$$(ClH_4N)_2{\cdot}Zn(NH_3Cl)_2 = 2NH_3 + (ClH_4N)_2{\cdot}ZnCl_2.$$

The solution remains clear after boiling. Zinco-di-ammonium chloride is decomposed by water alone into an insoluble part and a soluble part. The insoluble part is voluminous and flocculent when very finely-ground salt is employed, otherwise it is granular. It yields much ammonia, hydroxyl, and chlorine to analysis, but being slowly decomposed by washing, it has not been analysed quantitatively. The other and soluble part also consists of zinc, chlorine, and ammonia or ammonium. The action of water is therefore probably expressed by the following equation:—

$$3Zn(NH_3Cl)_2 + 2OH_2 = \underbrace{2HOZnNH_3Cl}_{\text{Insoluble Zinco-monammonium Chloro-hydroxide.}} + \underbrace{(ClH_4N)_2{\cdot}Zn(NH_3Cl)_2}_{\text{Soluble Ammonium and Zinco-di-ammonium Chloride.}}.$$

and the insoluble part hydrated, will be that which Davis examined, and to which he gave the improbable formula, $Zn(OH)_2NH_4Cl$.

Manganese dioxide—prepared free from lower oxides by heating manganese nitrate to 160° C., and thoroughly washing the resulting oxide—proved to be unaffected by digesting it for a long time with a solution of ammonium chloride.*

Manganese monoxide is slowly acted upon by ammonium chloride solution when cold, and much more rapidly when hot, ammonia being freely evolved, a little manganese going into solution, and the rest undergoing a striking transformation from its bright green self into a bright skin-coloured substance. This, by protracted washing on the filter-pump, becomes manganous hydroxide, with a very little chloride and peroxide (from aërial oxidation), and is probably, therefore, at first manganous hydroxy-chloride, HOMnCl, just possibiy ammoniated: it needs further examination. Its formation may be symbolised thus.—

$$MnO + NH_4Cl = ClMnOH + NH_3.$$

The manganese going into solution will be, no doubt, in the form of double chloride of manganese and ammonium.

Intermediate oxides, both native and artificial, are acted upon by ammonium chloride solution, a little manganese dissolving, and the remaining oxide approaching more and more the dioxide in composition. This oxide, however, has not been reached, even by repeated digestion with fresh portions of ammonium chloride solution. Even excellent pyrolusite yielded soluble manganese, in consequence, no doubt, of the presence of psilomelane, or other manganous compound.

Zinco-diammonium chloride dissolved in solution of ammonium chloride acts gradually upon artificially prepared hydrogen manganite, $H_2O_4Mn_2$, not only so as to cause manganese to go into solution, but also as to precipitate zinc on the manganite. For after digesting the manganite in the solution, washing it with ammonium chloride solution, and then thoroughly with water till the washings were free from chloride, zinc could be easily detected in it, though in small quantity. Before this treatment it was found to be free from zinc. The washing with ammonium chloride was practised as a precaution, although it was certain to remove some of the zinc from the manganite. The reaction must be as follows:—

$$(NH_3Cl)_2Zn + H_2O_4Mn_2 = 2NH_4Cl + ZnO_4Mn_2.$$

Native well crystallised manganite, ground very fine and subjected to the action of the same solution, did not appear to take up any zinc; nor did artificial sesquioxide and binoxide.

Zinc and dioxide of manganese were left in contact in a solution of ammonium chloride. Pure dioxide, prepared by heating the nitrate, was employed for this purpose. Some evolution of hydrogen still took place in contact with the zinc,† both zinc and manganese compounds went into solution, and ammonia was set free. The solution deposited a dark brown substance, manganic hydrate, on the sides of the vessel in contact with the air, just as an ammoniacal solution of manganese always does through aërial oxidation. The solid manganese oxide was removed from the solution after some weeks, and washed

* In "Watts's Dictionary," 2nd Suppl., p. 448, manganese dioxide is spoken of as acting on ammonium chloride solution. This is a mistake, apparently, through inadvertence, as it is not a direct statement, and has no real connection with the context.

† In Sylvanus Thompson's little book on Electricity, hydrogen is said to be liberated on the manganese dioxide when in galvanic circuit, this hydrogen being only slowly oxidised. But this I take to be an assumption, made to explain the rapid fall of the electromotive force of the cell through "polarisation," and gradual rise again when out of action, and not an assertion of observed fact.

twice with ammonium chloride solution, and then well with water. It had changed from a black to a distinctly brown colour, more evidently so after drying in a hot-water oven, and had lost its crystalline sparkle. It yielded both manganese and zinc to a solution of ammonium chloride. To a quantitative examination it yielded evidence of the presence of only 92·5 per cent of dioxide, the rest being manganous oxide and zinc oxide, besides a trace of water (dried at 100°). Careful treatment with metallic mercury failed to reveal the presence of the least trace of metallic zinc, which it was thought might just possibly be mixed with it accidentally.

Theory of the Cell.

The above experimental facts lead to the following theory of the action of the cell.

Primary Action.—This is the formation of hydrogen manganite and zinco-diammonium chloride—

$$\overset{(-)}{Mn_2O_4} + 2HNH_3Cl + \overset{(+)}{Zn}$$

become—

$$Mn_2O_4H_2 + (NH_3Cl)_2Zn.$$

Excess of ammonium chloride holding the zinc compound in solution until the point of saturation has been reached, after which the zinc salt crystallises out as it is formed.

Secondary Actions, causing "Polarisation."—The hydrogen manganite acts locally upon the zinco-diammonium chloride solution, and forms zinc manganite and ammonium chloride; but the formation of zinc manganite takes place much more rapidly by galvanic action when the cell is at work and zinc dissolving, thus—

$$\overset{(-)}{Mn_2O_4} + Zn(NH_3Cl)_2 + \overset{(+)}{Zn}$$

become—

$$Mn_2O_4Zn + (NH_3Cl)_2Zn.$$

The zinc manganite and the hydrogen manganite, by coating over the manganese dioxide, protect it from the primary action of the ammonium chloride and zinc, and thus cause the "polarisation" of the cell.

Secondary Actions causing Depolarisation.—The ammonium chloride dissolves manganous and zinc oxides out of the manganite, the manganous oxide liberating ammonia and rendering the solution much more ammoniacal than the zinc compound does.

$$Mn_2O_4Zn + 4ClH_4N = MnO_2 + 2OH_2 + Cl_2Mn + (NH_3Cl)_2Zn + 2NH_3.$$

The manganous chloride dissolves in the presence of the free ammonia as a double chloride of manganese and ammonium. By the solution of these oxides the manganese dioxide of the manganite becomes active again. The depolarising action proceeds slower than the polarising, and therefore the battery requires to be left uncircuited in order to recover its full power after use.

Local Actions.—A slight but distinct liberation of hydrogen on the surface of the zinc plate. Absorption of oxygen from the air by the manganese in alkaline solution, hydrogen manganite and ammonium chloride resulting.

Electric Deformations of Quartz.—MM. Jacques and Pierre Curie.—To every method of occasioning an electric disengagement in quartz by pressure, there corresponds a peculiar reciprocal phenomenon. Suppose a parallelepipedon having a surface normal to an electric axis and two normal to the optical axis, when there is a difference of potential between the two surfaces normal to the electric axis, the quartz expands along the electric axis, and contracts in the direction normal to the optic and electric axes, or inversely it contracts in the first direction and expands in the second, according to the direction of the tension. The third direction does not vary.—*Comptes Rendus.*

ON SOME ANALYSES OF A RECENTLY-DISCOVERED DEPOSIT OF GUANO IN AUSTRALIA.

By A. B. GRIFFITHS, F.C.S.,
Member of the Liverpool Association of Science and Arts, Medallist in Chemistry and Botany, &c.

The following analyses of a recently-discovered deposit of guano in Australia may be of some use to the readers of this journal:—

	I.	II.
Nitrogenous organic matter and ammonia salts*	46·721	46·730
Phosphoric acid..	15·021	15·100
Lime	17·999	17·985
Salts of alkalies	1·421	1·405
Sand	2·714	2·713
Water	15·918	16·067
	99·794	100·000

London, November 20, 1882.

NEW METHOD OF DETECTING DYES ON YARNS AND TISSUES.

By JULES JOFFRE.

(Concluded from p. 251).

Orange Colours.

The orange dyes may be divided into two groups, according to the nature of their reaction with potassa—

1. Those which it turns to a red or a brown.
2. Those upon which it has no action, or which it turns more to a yellow.

The first group embraces young fustic, yellow coralline, and two compound oranges, obtained respectively with young fustic and cochineal, and with turmeric and cochineal. These four dyes may be distinguished by their behaviour with potassa. A young fustic dye becomes a red orange-brown; coralline is turned to a splendid purple-red; the young fustic and cochineal-orange to a violet-brown, and the turmeric and cochineal dye to a reddish brown. Ammonia produces the same results as potassa, and perhaps with greater distinctness, the shades obtained by the reaction being brighter. There can be no confusion except with the last two dyes, but here the action of nitric acid removes all doubt. In the orange of young fustic and cochineal it produces no change, whilst it turns that of turmeric and cochineal to a fine red. This reaction must not be too much prolonged as nitric acid turns wool to a yellow. Hydrochloric acid has no action on the oranges of this first group.

The second group comprises modified annatto, hydrated ferric oxide, chrome orange, azo-dinaphthylamine, aurantia, phosphine, and nitro-alizarine. The behaviour of potassa furnishes some indications. Annatto-orange becomes yellow, and chrome-orange on woollen tissues becomes in time entirely black. Phosphine turns to a light yellow, but by washing in water the orange is restored. Aurantia becomes a deeper orange, almost red. Ferric hydrate is turned by hydrochloric acid to a light yellow, which disappears entirely on washing with water

The washing-water gives the reactions of iron.

Chrome-orange is turned almost white by hydrochloric acid. If the sample is incinerated chrome and lead can be detected in the ashes. Hydrochloric acid also turns azo-dinaphthyl-diamine to a grey-blue and aurantia to a light yellow, which is re-converted to an orange by washing with water.

Annatto, nitro-alizarin, and phosphine are not altered in their tone. These three dyes are distinguished by the action of nitric acid, which turns annatto at first green

and then discharges it; it has no action upon nitro-alizarin, and simply lightens the shade of phosphine. These two last colours are distinguished by the action of potassa, which turns phosphine to a light yellow, whilst it has no action upon nitro-alizarin.

Brown Colours.

We shall examine the brown obtained with sanders wood with potassium bichromate as a saddening agent, catechu, manganese-bronze, aniline-brown, and the compound brown dyed with a mixture of orchil, turmeric, and extract of indigo. Sanders-brown is turned slightly greyish by potassa, especially at the edges of the swatch, whilst it has no action upon the other browns. Manganese bronze is discharged by hydrochloric acid, which has no action on the other browns. In the ash the presence of manganese may be detected before the blowpipe.

The compound brown is turned by nitric acid to a deep red, which then grows paler and turns to a light orange-red. Nothing similar is produced with the other browns. The reagents have no effect upon aniline-brown and upon catechu, the tone of the former is much brighter and redder.

Grey and Mode Colours.

We consider here logwood-grey, Casthelaz-grey, carbon-grey, pearl-grey (obtained with extract of indigo and cochineal), and, lastly, the compound colours formed from turmeric, cochineal, and extract of indigo, or from picric acid, aniline-blue, and magenta.

Pearl-grey is turned to a rosy white by potassa, and especially by stannous chloride.

The mode obtained from turmeric, extract of indigo, and cochineal is turned brown-red by potassa, and orange by stannous chloride. That produced with picric acid, aniline-blue, and magenta, is turned yellow by potassa and green by hydrochloric acid.

Logwood-grey is turned to a fine red by hydrochloric acid. Castelhaz-grey turns to a violet with potassa, and to a blue with hydrochloric acid. Carbon-grey (lamp-black) is not affected by any reagent.

Black Colours.

The blacks are readily known by the action of hydrochloric acid. The old gall-black is decolourised; logwood-black turns to a fine red, but on woollens some little time is required.

Madder-black becomes brown, and ultimately a brownish orange. Lastly, aniline-black and lamp-black, which are not affected by the reagents, even the acids, are distinguished by their tones, aniline-black being full and deep, whilst lamp-black is merely grey. — *Moniteur Scientifique.*

PROCEEDINGS OF SOCIETIES.

THE ROYAL SOCIETY.

The Anniversary Meeting of the Fellows of the Royal Society for the election of Council and Officers for the ensuing year, and for the presentation of the medals in the gift of the Society, took place on the 30th ult., at Burlington House.

The President, Mr. Spottiswoode, in his address, gave a summary of the Society as carried out by by the council during the year, and particularised the subjects most worthy of attention.

The medals were then presented as follows:—The Copley Medal to Professor Cayley, F.R.S., for his numerous researches in pure mathematics. The Copley Medal, well-known throughout Europe, though of comparatively small value, is generally considered the highest distinction it is in the power of the Society to confer. The Rumford Medal, and the balance in money, to Captain Abney, F.R.S., for his photographic researches and his discovery of the method of photographing the less refrangible part of the spectrum, especially the infra-red region. A Royal Medal to Professor Flower, LL.D., F.R.S., for his valuable contributions to the morphology and classification of the mammalia and to anthropology. A Royal Medal to Lord Rayleigh, F.R.S., for his various papers on mathematical and experimental physics. The Davy Medal (in duplicate) to D. Mendelejeff and Lothar Meyer, for their discovery of the periodic relations of the atomic weights.

The following gentlemen were elected Council and Officers:—

President—William Spottiswoode, D.C.L., LL.D.

Treasurer—John Evans, D.C.L., LL.D.

Secretaries—George G. Stokes, D.C.L., LL.D., Professor Michael Foster.

Foreign Secretary—Professor A. W. Williamson, LL.D.

Other Members of the Council—Professor W. G. Adams, F.C.S.; John Ball, F.R.A.S.; Thomas Lauder Brunton, M.D.; Professor Heinrich Debus, Ph.D.; Francis Galton, F.G.S.; Professor Olaus Henrici, Ph.D.; Professor Huxley, LL.D.; Professor E. Ray Lankester; Professor Lister, F.R.C.S.; Professor Prestwich, F.G.S.: Professor Osborne Reynolds, M.A.; Professor Roscoe, M.D.; the Marquis of Salisbury, K.G.; Osbert Salvin, M.A., F.L.S.; Warington W. Smyth, M.A., F.G.S.; and Edward James Stone, M.A.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, October 26, 1882.

Mr. John Pattinson in the Chair.

Mr. B. S. Proctor's Inaugural Address.

(Continued from page 254.)

We may suppose the crystalline cohesion of the alumina was the effect of a polarity of its molecules which determined their set in the regular crystalline form; a polarity which is not destroyed by fusion with potash, or by union with acids, but which is satisfied or temporarily neutralised by any of these conditions. The polarity which causes crystallisation at one time effects union with acids at another. A confusion arises through regarding cohesion as a force, rather than the effect of a force. Probably cohesion and adhesion differ only in name, the force being the same. We call it cohesion when it causes two molecules of the same nature to join, and adhesion when the effect is the joining of two molecules of different natures. Let us assume that molecules are endowed with polarities, which are the cause of crystallisation, cohesion, adhesion, solution, &c.,—polarities which, like magnetism, are satisfied by meeting with equal and opposite polarities. Let us assume that molecules may have several axes of polarity which may differ much or little in intensity, we may speculate that viscosity is caused by a *multipolar* attraction of approximately equal intensities in different axes, and of a strength intermediate between those existing in solid and liquid states. We may suppose that mob lity is the result of equality and feebleness of multipolar attractions; that the colloid state is consequent on equality with strength of multipolar force; that a crystalloid has strong and unequal polar forces which determine the arrangement of the molecules in the lines of their strongest polarities. We may suppose, when sulphate of soda or any other salt dissolves in water, that the polarity of its molecules is satisfied by the attraction of so much water as is required to make a saturated solution; and this polarity being satisfied, further water is miscible with it in all proportions. The greater solubility at higher temperatures probably arises from a weakening of the polarities as the effect of heat, an effect which is evident to us in the case of magnetism and iron. The stronger

polarities probably diminish in greater degree than the weaker till fusion takes place, when the forces are approximately equal in all directions, and further diminish as temperature rises, till volatilisation is effected, when molecular attraction seems to vanish altogether. This all appears reasonable enough in the case of sulphate of soda and water, where the proportion between the salt and the solvent is such that we may suppose the molecules engaged on the phenomena are within the sphere of probable attraction, but when we come to such salts as chloride of silver, sulphate of baryta, &c., how can we suppose that one molecule of the salt can come within the sphere of attraction of so many molecules of water as are required for its solution? This has appeared to me a difficulty in all the theories of solution commonly propounded. If 100 molecules of water by their adhesion cannot overcome the cohesion of two molecules of sulphate of baryta, how is it likely that 1,000 or 10,000 can attack the particle at the same moment?

How can we conceive of one molecule of chloride of silver being maintained in solution by its adhesion to 100,000 molecules of water? And the adhesion of 50,000 molecules of water is insufficient to restrain it from union with some other molecule of chloride of silver which may be adhering to 50,000 contiguous molecules of water?

Hydrogen dissolves in 50 volumes of water, or by weight, 1 in 12,500, or by atoms, 1 in 1400; probably this is much the same as saying that the molecules find freer space for their movements between the molecules of fluid water than between those of the atmosphere of gaseous hydrogen from which the solution is taking place. The active movements in the hydrogen atmosphere tend to throw out molecules into any space freer than the atmosphere, and will so throw hydrogen into the water till the water is as crowded with hydrogen molecules as the hydrogen atmosphere itself, and then it is probable that interchanges will take place, but the number of molecules thrown into the water will be just equal to those thrown back from the water into the hydrogen atmosphere, and so there will be maintained a definite relationship between the proportion of hydrogen "absorbed" or "dissolved" by the water, and the temperature and pressure of the hydrogen atmosphere in contact with it. This doctrine is so nearly the common one in reference to gas and water that my statement is like an oft-told tale. But if we apply the same idea to the solution of chloride of silver it affords us at least some material for thought and speculation. The quantity of chloride of silver in its saturated solution in water is less than the quantity of air in an equal space of an ordinary air-pump vacuum, but more than in the high vacua used for radiometers or Swan lamps.

A cubic inch of air, attenuated to the thousandth of an atmosphere contains $\frac{3}{10000}$ of a grain of N and O. A cubic inch of saturated solution of chloride of silver contains about $\frac{2}{10000}$ of a grain of AgCl. But the highest authorities tell us that even in the most perfect vacua attainable, the molecules are crowded almost inconceivably closely together, and in numbers quite beyond our powers of thought. The limit of solubility seems more probably determined by the relation of the molecular motions of the AgCl to this state of crowding than to any adhesion between the salt and its solvent, using the word adhesion in its customary sense. The flight of molecules of AgCl through the water would give them mean free paths of appreciable length before coming into contact with others, or within influence of their polarities and movements.

The movements of the AgCl in relation to those of the water may be compared to the movements of a comet in relation to a planetary system. The comet comes in and obeys the central commanding force and is temporarily part of the system, but is whirled away again into space, so the mass of AgCl, by a temporary influence of the water, throws off an atom which, passing through a cometic orbit, having too distant a harmony with the aqueous sun to be retained in its system passes into the aqueous space till it comes under the influence of a molecule or a mass of its own nature, with which it unites and passes out of solution.

The effect of heat is no doubt to weaken the molecular polarities, thus facilitating the disintegration of solids, but at the same time weakening the polar attraction between the solid and the solvent. The increased or decreased solubility with a rise of temperature will depend upon whether the polar attractions among the molecules of the solid diminish more or less rapidly in proportion to the increased temperature, than the polar attractions between the solid and the solvent. Of course we expect the molecular movements of one drop of water to be just the same as of another, and we know they unite instantly and perfectly. The molecular construction of oil of turpentine or other essential oil we believe to be very different, and probably their molecular movements are inharmonious with those of water, resulting in the small degree of solubility between them, while the complicated and heavy molecules of the volatile oils having sluggish movements dissolve freely among one another.

In the various alcohols we have a step by step increase in complexity of molecular structure, with a like increase in density and decrease in mobility; at the same time we find the light mobile alcohols miscible with water in all proportions, the heavy alcohols insoluble in water but soluble in oils; the light alcohols standing between water and the heavy alcohols, and having considerable intersolubilities with both.

The molecular motions and polarities of water are probably considerably influenced by most substances which may be dissolved in it, especially in those cases where one body has a conspicuous influence on the solubility of another, with which it does not enter into combination or decompose. Such, for example, as ammonia, which when present in large proportion has power to throw out of solution the double sulphate of copper and ammonia. The molecular relationships of the water are evidently much influenced by the great affinity of the ammonia; they are also much influenced, though in a different direction, by the great affinity of carbonate of potash when added to saturation; the saturated solution not being miscible with a strong solution of ammonia. On the other hand, the sparingly soluble bodies probably have their molecular movements and polarities comparatively little influenced by the water, as in the case of hydrogen and oxygen, which may both be dissolved in water, though only to a small extent, and yet not enter into combination with one another. We regard the liquid condition as that most favourable to the combination of bodies having a tendency to unite, and yet the great affinities of O and H fail to bring them into union. Probably the affinity between the water and these two gases is so small as to exert very little influence on their movements, and leave them virtually in the free and gaseous state, occupying, as it were, only the interstices of the water. The case is necessarily different with ammonia, where the proportion is so great that we cannot suppose it to retain a molecular condition or mobility in any degree approaching that of its gaseous state. And the case is also very different when O and H are condensed upon the surface of platinum, where the amount of condensation is so great as to preclude the idea of a truly gaseous condition of the molecular movements, and where the affinities are brought into effective play. The great affinity of ammonia for water is seen not only in its abundantly taking the liquid form by their union, but also by its power to throw the carbonate of potash out of solution, when passed in the gaseous state through a saturated solution of this salt. Ammonia very much diminishes the solvent power of water for many other salts, but has no appreciable action on the solubility of ether, chloroform, sugar, or gum.

I am not prepared to suggest any more definite relation between a substance and its solvent, than a harmony of molecular movements, and the existence of molecular polarities acting between the solid and the solvent, which enable the movements of the solid to throw off

molecules under the influence of the motions and polarities of the solvent, with rates of frequency peculiar to the solid and solvent under consideration, and allow the reattachment of the molecules of the solid to one another when the number of molecules of the solid to those of the solvent is beyond a ratio peculiar to themselves.

I think there is every reason to believe that the polarities of crystalline bodies by their inequalities cause the set of the matter in the crystalline form. I think there is also probability, though not yet so strong, that in amorphous or less crystalline bodies the intensities of the molecular polarities are more equal, and that bodies which are capable of taking both forms have polar intensities differing to so small an extent that a slight change of circumstances may determine the orderly or the heterogeneous arrangement of their molecules. It would be reasonable if such were the case, that the amorphous condition should be the less resistant to mechanical or chemical change, *i.e.*, should be softer, more soluble, more prone to enter into chemical combination. To illustrate my meaning, some substances may be thrown down as amorphous precipitates, becoming crystalline by time; the polarities being weak or of nearly equal strengths, the molecules attach themselves together in heterogeneous contact of those points which were nearest at the time of the formation of the new compound, and, being thus less combined, they are more readily dissolved by the mother-liquor. But some crystalline particles get formed, and are always surrounded by mother-liquor holding in solution more than the normal proportion of the salt. The crystalline particles are, therefore, always in circumstances to grow in size by attachment of more molecules drawn to them by the crystalline polarity; this reduces the solution to a strength below that at which it is capable of taking up the amorphous salt. The crystalline part of the precipitate is thus always growing, and the amorphous is constantly being dissolved till all has become crystalline. The whole phenomenon is very beautifully seen by aid of the microscope in the process for detecting traces of strychnine by precipitation with ferricyanide of potassium.

A drop of solution of strychnine on the microscope slide, being touched with a minute fraction of a drop of a solution of the ferricyanide, and the precipitate immediately examined under a half-inch objective, shows an amorphous cloud which quickly commences to exhibit a few crystals of a beautiful star-like shape. Around these the nebulous precipitate rapidly dissolves, leaving a clear space into which the stars expand, while the clouds clear away till all is bright and beautiful. Unless care be taken, it is sometimes difficult to repeat this experiment, as a trace of crystalline salt determines the rapid and less regular crystallisation of the whole precipitate at once.

In this and many other cases the substance is capable of taking either of the two conditions distinctly. There are many in which a precipitate is apparently amorphous, though probably only so in appearance, from being in too minute a condition for its crystalline form to be noted under the microscope, and a considerable number of bodies exist in which no trace of crystalline property has yet been discovered, the most perfect of these being the gelatinous or colloid bodies.

The gelatinous state itself is probably due to polarities in the molecules acting equally in all directions. The hydration of colloid bodies has always appeared to me to be a subject worthy of speculation and of experiment. Its study relates to a debateable condition between the solid and the liquid state. We can trace every degree of change without any clear separation, from the most perfect fluidity through a great variety of watery combinations to the most perfect solidity and the most perfect insolubility, without losing the connection between the water and the solids with which it is brought into operation.

There is the most perfect gradation from the solution of ammonia, which is lighter and more mobile than water itself, through the solutions of crystalloid solids which add but little to the viscosity of the water, to solutions which are syrupy; to solutions of gums which are mucilaginous fluids or gelatinous semi-fluids; to combinations of water with gelatine or albumen, which, by change of temperature, become fluid in one case or lose fluidity in the other; to silica, which may be precipitated as a transparent gelatinous mass from a dilute solution, or as a pulverulent and opaque precipitate from a concentrated liquor; to clay which in small quantity remains diffused through pure water, with a persistency suggesting a union approaching that of solution, and from which it may be precipitated by hydrochloric acid, and to clay in its plastic state which presents some analogies to hydrated colloids. Thus through many links till at the end of the chain we come to pure siliceous sand and other pulverulent bodies, which retain the one remnant of analogy to solubility, that they are always left in a more coherent state by evaporation of water in which they have been immersed, than by lying in dry contact during any observable time.

I cannot at present enlarge upon more than one or two of the many suggestive links which merit study in this chain; first, as to the great force (molecular polarity I will assume) by which the gelatinous colloids are held together, and how great a force is represented by their union with water; and then to the adhesion, or cohesion of precipitates on the evaporation of water in comparison to the adhesion of the same substances under dry pressure. As regards the coherence of gelatinous colloids glue affords a convenient illustration. One part of gelatine dissolved in 100 of hot water makes a jelly on cooling. One molecule of gelatine confers proximate solidity to 100 times its weight of water; the molecules of gelatine may be regarded as separated from one another by this large proportion of water intervening, and still to have so much hold upon one another—still to be so strongly under the influence of one another's polarities, that they are held in position and not free to move, though the jelly is tremulous and easily broken. We might expect the polarities to increase inversely as the squares of the distances of the molecules, and to become something considerable as the water is diminished, and this is the fact to a larger extent than is often supposed. A solution of gelatine evaporated in glass or porcelain vessels contracts so much, and with so much force, as to tear away the surface of the vessel, thus indicating that the molecular attraction of the gelatine is at least as great as that of glass or porcelain. I have here specimens of glass and porcelain thus fractured. I had long ago heard of such results, but heard of them with a reservation of faith till a few years ago, when experimenting with gelatine, my beaker fell a victim to this adhesive, cohesive, and contractile force. The effect on the evaporating dish is equally interesting. The force evidently exceeds the tensile strength of glass and porcelain, and if measured by pounds per square inch must be something considerable, but probably all the molecular forces would be large—indeed ungovernably violent—if our engineers were reduced to the size of molecules.

If the molecules of gelatine are held together with this great force, the force with which water attacks them must be equally great to enable it to penetrate the gelatine on immersion and expand it as it does. The swelling of a substance by becoming damp is frequently spoken of as the result of capillary attraction. I believe, however, that in most cases, if not in all, where swelling action takes place, it is the result of colloid hydration rather than capillarity. It is worthy of a passing remark, that while gelatine diffuses to a small extent only in water, water penetrates to a large extent into gelatine, and in contrast to this crystalloids diffuse into water, but water does not penetrate into a mass of solid crystalloid, though it diffuse into a solution of the same.

Turning now to another point, which I can do no more than touch upon, we may take pure siliceous sand and wash it with the greatest care in distilled water, finally decanting the water and drying a small quantity of the sand in a beaker by evaporation; the particles of sand adhere to one another and to the beaker with sufficient force to

permit of the inversion of the beaker without the sands falling out, though, if once disturbed after it has become dry, the adhesion instantly disappears, and does not show itself again after a long period of rest in the dry state. What is the nature of this adhesion, and what part the water takes in bringing it about is, as yet, problematical; we note the same effect in all bodies in varying degrees, from gelatine down to sand; it is not proportionate to the solubilities of the bodies in which it takes place. No doubt solubility has an effect of this kind, but we cannot regard the phenomenon as simply dependent on partial solution and the cementing of the undissolved particles, by means of the dissolved portion, left as a residue on evaporation.

The effect is so variable in amount among bodies nearly equally insoluble—for example, sand and clay—sand having the loosest possible adhesion, and clay a considerable one. It is more likely that the superficial molecules in a particle of sand or clay have one side of the molecule free to exert an affinity on the water, and that one side of the molecule is thus in the condition of hydration, the difference being that in hydrated colloids both sides of the molecule have water attached, and the action extends to every molecule in the mass. On this supposition, when the water is evaporated, adhesion should take place wherever two molecules of silica come in contact, and the amount of adhesion should be proportionate to the relation between the size of the particles and the size of the molecules.

In a very interesting paper on regelation and the uniting of powders into masses under pressure, Professor Spring notices incidentally the disposition of powders kept in bottles undisturbed for a length of time, to become united into masses which are more or less strongly coherent as they have been undisturbed for a longer or shorter time, and he attributes this result to a disposition possessed by most substances, but he thinks by crystalline substances especially, to weld when submitted to pressure—to unite promptly and perfectly under powerful pressure, or slowly and imperfectly under the pressure of their own weight. That many powders do agglomerate in our bottles is well known to us all, but the cause of their agglomeration I should think is mainly due to the action of moisture and change of temperature. The tendency to absorb moisture is not confined to deliquescent substances, or to substances commonly known as hygroscopic, but is probably possessed by all matter which has been carefully dried. In non-deliquescent salts the absorption of moisture ceases before the salt becomes palpably moist, but not before the particles are coated with an infinitesimal film of saturated solution of the salt. This film increasing in moist states of the air, and evaporating under the reverse circumstances, is sufficient to cause the agglomeration of the powder by a species of crystalline soldering of one particle to another. The same result would be produced by changes of temperature increasing or diminishing the solubility of the salt in its watery film. There is scope here for a series of careful observations which could not fail to be instructive. Professor Spring's results have had a great interest for me, perhaps the more so, as his conclusions are in some points opposite to my prejudices. He thinks that softness and a crystalline nature are, if not essential, at least favourable to this welding by pressure. Some years ago, when Professor Brayley was lecturing on Physical Geography to our Literary and Philosophical Society, I performed for him an experiment in regelation, in illustration of his remarks upon glaciers, the point being the uniting of two pieces of ice while immersed in warm water. He expressed to me his conviction that it would ultimately turn out that regelation or welding could only take place with matter in a colloid state. That ice, though crystalline in freezing, was probably colloid in melting, that iron, though feebly crystalline while cold, became colloid at a welding heat, and so on. He did not consider these points sufficiently mature for publication, but we discussed them as matters of interest to be kept in view as the subject of regelation and welding might develop, and I must say I felt strongly inclined to his view. I anticipated that the condition of matter which facilitated welding—using the word in a wide sense, was the reverse of that which is most favourable to, and most characteristic of, crystallisation. My idea of crystalline matter was that the molecules had such polarities as caused their arrangement in a regular crystalline form, and the molecules would have little or no tendency to unite unless presented to one another in the position of this normal arrangement, and that colloid bodies consisted of molecules which cohered together in obedience to polarities which were not selective in their action, but which would cause the molecules to unite and cohere in any position or arrangement; and that welding or cohesion should take place when, by mechanical means, the masses could be brought together as closely as are the molecules within the masses. On this supposition welding should be a general property of such amorphous bodies as are soft enough to admit of their surfaces yielding so as to adapt themselves perfectly to one another. Practically, however, we had only a very limited experience of this till Professor Spring announced the success which he had achieved in uniting a great variety of powders by submitting them to pressures varying up to 20,000 atmospheres. I repeated a number of his experiments, and added others, and have now the pleasure of laying before you a few typical examples of the results. I had intended embodying, in the present address, some account of these experiments, but I find time will not permit me to do so at present, though it is possible I may find another opportunity of giving you a few details.

If we take a comprehensive view of welding, it is evident (without recourse to Professor Spring's experiments) that it accompanies a soft or semi-fluid condition rather than either a crystalline or colloid nature. The running together of two dew drops on the petal of a flower is the same thing in principle as the union of zinc filings under the pressure of 10,000 atmospheres in Professor Spring's apparatus, or the welding of the coils of a 100-ton gun in Sir W. G. Armstrong's works. Solidity and fluidity are but the different parts of an unbroken chain. The dewdrop on a rose retains its rotundity against the force of gravity, in obedience to the greater force of its molecular attractions. On the other hand, the molecular attractions of the metal, great as they are, yield to the greater force of mechanical pressure, and zinc flows under the force of 10,000 atmospheres, or iron welds under the combined forces of the furnace and the forge. The probability is that all things would weld under circumstances such as would make them flow; that is, the molecular forces within the mass must be reduced or the external forces must be increased till the latter are at least equal to the former.

Pharmacists have long been familiar with the welding tendency of powdered camphor, aloes, and other soft bodies of either a crystalline or amorphous nature. I should have felt considerable surprise if there had been a general difficulty in causing the welding of amorphous or colloid bodies, and among the first experiments I tried, after ascertaining that I could readily obtain Professor Spring's general results, were those to determine the welding power of sundry familiar colloids. Gum, sugar, starch, gelatine, resins, and amorphous salts were tried with the general result that amorphous bodies unite in a very similar degree and manner to the crystalline.

Amorphous sugar welds rather more easily and rather more perfectly than crystalline sugar under the same pressure. With crystalline and amorphous chrome alum there was no appreciable difference. The double citrate of ferric oxide and ammonia, though an amorphous salt, unites perfectly and readily; so does the double sulphate of the same bases which is a crystalline alum.

Though I have ceased to believe with Brayley that the colloid condition is an essential preliminary to a good weld, I have not learned to think with Spring that it is less favourable than the crystalline state; a definite judg-

ment upon this point must be reserved for a much more extended evidence.

Professor Spring has obtained several other results no less interesting; he has shown that sulphur, in whatever condition it is put into the press, assumes its densest condition under pressure. Whether amorphous or prismatic in the first instance, it becomes octahedral by compression. Thus pressure is capable of producing molecular change, and the allotropic condition which is possessed of the greatest density. He has also submitted a mixture of copper filings and sulphur to a pressure of 5000 atmospheres, and obtained a block of sulphide of copper, showing that the pressure which suffices to cause the welding together of the particles of sulphur, or the particles of metal if applied to them separately, has the power of facilitating their chemical union if applied to them when mixed, but he thinks that such chemical union only takes place when the resulting compound occupies less space than the two elements in the separate state. In illustration of this I have upon the table a little block obtained by the same treatment of a mixture of sulphur and powdered tin, in which mechanical union and cohesion have been obtained, but not chemical union, the sulphur being still visible with the aid of a lens. There is here a resistance to blending, which we may compare to the immiscibility of oil and water, or to the aqueous solutions of ammonia and carbonate of potash previously noted, a resistance which we may suppose to be due to a want of harmony in the molecular movements of the bodies concerned, a discordance which is not removed by pressure such as we can apply, but which is removed by an increase in temperature. We may suppose the discordance to be similar to that of phosphorus and oxygen in the cold, where the union is retarded by pressure, and expedited by the reduction of pressure, or the increase of temperature. If the molecular movements of two elements in the separate state take place in one plane, the composition of these motions may result in a motion occupying more space, less space, or the same space as that occupied by the sum of the original elementary motions, but if the elementary motions are in different planes the result is a movement occupying more space than the sum of the previous movements. Under these circumstances there is a natural obstacle to this composition of forces, if the elements are brought together in a space too small to allow of the resultant motion. This is probably another way of putting the conclusion at which Professor Spring had arrived, *i.e.*, that combination takes place when the resulting compound has a greater density than the mean of the two elements, and does not take place if the density is less than the mean.

Chemical action is probably the influence or effect of the force exerted by molecules of one nature upon the motions of molecules of a different nature, and having different kinds of movement; the resulting motion determining the nature of the resulting compound, and the action taking place when the differing molecules come in contact, or, if we accept the current theory, that the spaces between the atoms in solid bodies is large in comparison to the size of the atoms, instead of saying when the atoms come in contact, we must say when the ethereal atmospheres which surround them, come in contact. The idea that combination is the result of a harmony of some of these molecular movements is supported by the fact, that mechanical union takes place when powdered sulphur and chlorate of potash are powerfully compressed, and that chemical union takes place when they are powerfully rubbed together, the harmony of their molecular motions not being close enough to cause chemical union till the mechanical motion of friction assists, probably by altering one or both of the molecular motions, in such a way as to make them harmonise more closely, or by the mechanical disintegration of particles disturbing the polarities of the simple body, as chemical decomposition effects the nascent state of molecules liberated from chemical union. Friction is said to ignite a match by causing heat. Why not say it causes chemical action directly? We have no evidence that heat is produced *before* the chemical action, except the general experience that heat is one of the results of friction; and no evidence at all that the chemical action observed is due to the heat produced by the friction. We also know that light and electricity are results of friction, and though light is said to be one of the evidences or consequences of a certain degree of heat, we cannot for a moment admit that light is invariably an evidence of heat, or at least of that degree of heat which is said to be luminous, and when, by rubbing two quartz pebbles they shine in the dark, there is scarcely a possibility that any portion of the stone has been raised to the temperature of incandescence. Again, if, instead of quartz, we take loaf sugar for the experiment, the sugar would not bear a temperature capable of producing light through the development of a luminous heat. It is not more philosophical to say—*friction produces molecular motions of various degrees of intensity, which manifest themselves as heat, light, electricity, or chemical action?* In the friction light of quartz the yellow rays preponderate, while in the friction light of sugar the blue rays preponderate, and both are no doubt accompanied by that lower grade of molecular motion which is known as non-luminous heat, and possibly also by electricity. The odour of the rubbed quartz may be the result of chemical action, though of what nature we have no evidence; it does not resemble ozone, though it might be a silica compound of a parallel nature.

(To be continued.)

NOTICES OF BOOKS.

Manual of Blowpipe Analysis, Qualitative and Quantitative, with a Complete System of Determinative Mineralogy. By H. B. Cornwall. New York: D. Van Nostrand. London: Trübner and Co.

The object of the author of this work has been to furnish a complete guide in all branches of blowpipe analysis. To a great extent Prof. Cornwall has followed Plattner, especially, as is stated in the Preface, in Chapters III. and VII., as well as in the Section on Quantitative Blowpipe-work. But there are several distinct features. We find here a chapter on the characteristics of important ores, and a systematic procedure for mineralogical determination, in which the blowpipe is as far as possible employed, to the exclusion of the wet methods. A part of these instructions in determinative mineralogy is taken from the works of Von Kobell and of Naumann. The entire treatise is written not as a manual of reference for the matured chemist, but rather as a class-book for the student. Hence it includes details and repetitions useful to the latter, though to the former unnecessary.

The author begins with directions for self-instruction, based on the supposition that the student is acquainted with the rudiments of inorganic chemistry.

In the first chapter he treats of apparatus, reagents, and operations. Like not a few good authorities, he gives the preference to a blowpipe with a trumpet-shaped mouthpiece. We may here be permitted to say that the choice of a mouthpiece depends very much on the shape of the mouth to which it is to be applied. For persons with thin muscular lips the inverted mouthpiece is preferable; they feel no weariness from prolonged blowing, whilst, on the other hand, they cannot well adapt the lips to a trumpet or bell-shaped aperture. The latter is undoubtedly preferable for persons with full, protrusible lips. The author fully recognises that "the best form of lamp for all general use, and the only trustworthy one for quantitative work, is that of Berzelius." Among supports we find mention only of charcoal, glass tubes, and platinum wire, foil, and spoons. The chapter concludes with general operations in analysis by the moist way.

The second chapter treats of general operations and examinations in qualitative blowpipe analysis, and concludes with Plattner's Table of the behaviour of alkalies, earths, and metallic oxides before the blowpipe.

In the third chapter we find special tests necessary for the elements in special combinations, whilst the fourth gives instructions for the systematic blowpipe examination of unknown substances.

Chapter V. gives, briefly, directions for the detection, in the moist way, of substances most commonly met with under conditions which do not admit of their detection by the blowpipe alone.

The sixth chapter consists of three pages devoted to spectrum analysis.

Chapter VII. treats of the use of the blowpipe in quantitative analysis, with especial notice of silver, gold, copper, lead, bismuth, tin, cobalt and nickel, and mercury. Instructions are also given for the blowpipe assay of iron ores, the iron only being determined, and of coal.

The ninth chapter is devoted to an account of the appearance and characteristic reactions of the more important ores and fuels, whilst the last chapter treats of determinative mineralogy.

There are sixty-nine illustrations, an index to minerals, and a general index, which, as far as we have tested it, appears accurate.

For the purposes for which this work is designed it may be safely recommended, and it is a further proof of the fact that more attention is paid to the blowpipe in America than in England.

Magnetism. By Thomas P. Treglohan. London: Longmans and Co.

From the Preface of this little work we extract two sentences which in substance, though not in wording, we have too often met with :—"This work has been written to supply a want long felt by students who are preparing for examination in the Elementary Stage of the Science and Art Department, so that the subject may be simplified and their studies facilitated by treating it under the divisions laid down in the Syllabus of the Department."

Again :—"The questions at the end will be found useful for examination purposes, and the author would suggest a thorough study and mastery of the principles contained in them."

These two sentences sufficiently show the character of the book. The questions referred to are those which have been set by the Science and Art Department in the years from 1867 to 1882, arranged in chronological order. One of these questions might somewhat amuse the irreverent. "People sometimes say 'the earth is a magnet.' What do they mean?" The answer lies very near: "Often they do not know!"

We are glad to find that this little work follows a more rational procedure than do not a few of its class. Every point is shown to the pupil experimentally, who afterwards reads concerning the meaning and the connection of what he has seen. This is the true way of teaching.

Notes on Chemical Calculations, with Examples. For Use in the Leys School. By A. Vinter, M.A. Batley: J. S. Newsome.

Works of this class appear to be increasing in number, and may perhaps become as plentiful as the ordinary chemical manuals. They must always be the despair of the reviewer, since they afford scope neither for praise nor blame.

Pennsylvania Pharmaceutical Association. Proceedings, 1882.

Perhaps the most interesting part of these Proceedings, from our point of view, is the Report of the Committee on Adulterations. We find mention of "vermillion, free from mercury but of handsome appearance. It was said to be orange mineral, tinted with eosine." On the list is sodium hyposulphite adulterated with sodium sulphate to the extent of about 28 per cent, and quinine sulphate containing 75 per cent cinchonidine sulphate. Cream of tartar is sophisticated with 14 to 90 per cent of clay, lime, starch, carbonates, and sulphates. Crude gas-tar is sold as crude carbolic acid. Indeed one sample of this article contained no carbolic acid at all, and merely 10 per cent of cresylic acid.

In discussing the question of pharmaceutical education a Dr. Wolff says—"I think it is an outrage to work a man from 5 in the morning until 11 at night." If such are the hours of labour in America we need not wonder at the words of warning which Mr. Herbert Spencer uttered before his return to England.

A paper was read by Mr. Gustavus Pile recommending Beaumé's hydrometer. What advantages this instrument has in comparison with the direct specific-gravity scale or with Twaddle we have never been able to see.

The enactment of further restrictions on the sale of "poisons" is discussed. The Draft Bill contains a proviso that the sale to agriculturists of such articles as are commonly used by them as insecticides is not to be interfered with. This is, so far, rational enough; but why may not the numerous other persons who employ poisons in the arts and manufactures claim a similar privilege? And why should the sale of poisons be restricted more than that of explosives and ammunition?

CORRESPONDENCE.

WATER ANALYSIS.

To the Editor of the Chemical News.

Sir,—A perusal of Mr. Reuben Haines's paper on the above (Chemical News, vol. xlvi, p. 237) has called my attention to some laboratory memoranda which, though entombed in my note-book since 1869, may be useful to-day. The few suggestions I have to make are the following:—

Ammonia-free Water.—I have observed that Manchester water, to which has been added 30 drops or so of sulphuric acid per gallon, yields a distillate that does not give the Nessler reaction on 100 c.c. A large glass retort is used, and only half filled to avoid spirting. As the volume in the retort diminishes it is restored with hot acidified water from another vessel, and the operation continued. The acid retains not only the free ammonia, but also such ammoniacal bases as may arise from a splitting up of nitrogenous matter in the water. A distillate prepared in this way has been found to answer all the requirements of Mr. Wanklyn's process. When the water is intended for air washing by Dr. Angus Smith's methods it should be rendered alkaline with ignited sodic carbonate, and redistilled.

Alkaline Permanganate.—Take rather more of the manganic salt than directed. Place in a clean flask, and wash twice by slight agitation with 50 c.c of water each time. When the washed salt and the potash have been dissolved in the requisite amount of water the solution is boiled in a flask for some time, adding ammonia-free water to supply the loss. Most workers, I believe, adopt the plan of boiling to remove ammonia, though it may not be a general practice to wash the permanganate crystals, or to further boil the measured quantity of the oxidising solution with a little ammonia-free water just before putting it in the retort. I can recommend both these precautions for ensuring the absence of ammonia from the alkaline permanganate, though perhaps some apology is needed for recording them, since they will probably occur to most analysts.

Nessler Solution is conveniently kept in a capped bottle from which the inner stopper is removed. The ground surface of the cap is smeared with soft paraffin. In this arrangement there is no stopper to get hopelessly fixed, or cork to become rotten and fall into the solution. Mr. Haines's remarks on swilling out his retort condenser and trial tubes just before use are quite to the point. A medical pupil in this laboratory, anxious to see his apparatus bright and clean, used a towel, the corner of which he had dexterously inserted to the bottom of each trial tube. This misapplied zeal for cleanliness raises a smile when one reflects on the extreme delicacy of the Nessler reaction, and the condition, both material and chemical, of most laboratory towels. All trial tubes and pipettes, after thorough cleansing with acid and alkali, should be well rinsed under a tap, and finally with distilled water *immediately* before use. The stem of the retort should be drawn off so as to form a shoulder, on which the black rubber tube connecting it with the condenser is secured by binding with string.—I am, &c.,

PHILIP HOLLAND.

18, Exchange Street, Manchester.

A CORRECTION.

To the Editor of the Chemical News.

SIR,—On page 319 *Proceedings A. A. A. S.*, Boston (1880) Meeting, are two analyses showing the effect of heating with dilute acids on rotatory power of grape sugar. I desire to add that I omitted to take any account in this experiment of the "birotation" of commercial grape sugar, since at that time I supposed this phenomenon was confined to the crystallised varicty. The great loss in rotatory power shown by these two experiments, therefore, is not due to the cause assigned in the paper.—I am, &c.,

H. W. WILEY.

The La Fayette Sugar Refinery,
La Fayette, Ind., November 20, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Chemiker Zeitung.
Vol. vi., No. 50, August 31, 1882.

Notices of Patents.—We find here abstracts of W. Majert's process for the preparation of violet and blue dyes by the oxidation of a mixture of phenols, or para- or meta dihydroxyl derivatives of aromatic hydrocarbons, with the sulpho-acids of aromatic para-di-amines in a neutral solution (German patent, No. 18,628). Also the proposal of Hutinet and Lamy for preparing bromised, iodised, and chlorinised photographic gelatine paper (German patent, 18,794). Also C. H. Roeckner's process for recovering soda from lyes in a manner not to be understood without the accompanying cut (No. 18,493). Also improvements in obtaining green dyes from the tertiary phenyl-amines (No. 18,959), and R. Rickmann's process for obtaining "blanc fixe" (No. 19,073).

Curious Laboratory Explosion.—H. Deibel.—For obtaining an aqueous solution of hydriodic acid, 100 grms. iodine were covered with an equal weight of water, and ordinary phosphorus was added in fragments until the liquid was colourless. The solution was then freed from suspended phosphorus by filtration over asbestos, and was distilled until almost all the hydriodic acid had passed over, and the residue in the retort had become a thick syrup. On removing the flame the retort was filled with white fumes, and an explosion shattered the apparatus.

New Method for Determining the Flashing-Point of Petroleum.—Leo Liebermann.—The author's process cannot be rendered intelligible without the aid of the accompanyiny illustration.

Incombustible Writing and Printing Paper.—Asbestos of the best quality is treated with potassium permanganate, and then with sulphuric acid. 95 per cent of such asbestos is mixed with 5 per cent of wood pulp in water containing borax and glue. A fire-proof ink is made of platinous chloride and oil of lavender, mixed, for writing with Indian ink and gum, and for printing with lamp-black and varnish.

No. 51, September 7, 1882.

The Schaffner-Helbig Process according to L. Mond.—The author maintains that by his own process from 50 to 60 per cent of the sulphur is recovered by Continental manufacturers, though only from 30 to 33 per cent have been obtained in England. He contends that the residues from the Schaffner-Helbig process are not pure calcium sulphide, and that the final result is not pure calcium carbonate, but a mixture of substances capable of being used as a substitute for limestone in the Leblanc process only to a certain extent. He thinks that a financial comparison of the two processes is for the present premature.

Is the Production of Carbon Dioxide or of Carbon Monoxide promoted by Combustion of Coal at High Temperatures?—Prof. Ledebur.—The author shows that, contrary to the usual opinion, the relative yield of carbonic acid decreases with a rise of temperature, and at 1100° is only 1·3 per cent.

Preparation of Potassium Carbonate from Potassium Chloride.—B. Wittgen and E. Cuno.—Mix concentrated solutions of potassium chloride with zinc oxide, hydroxide, or carbonate, and treat with carbonic acid in closed vessels. Zinc chloride remains in solution, whilst a double potassium-zinc carbonate is deposited, and is decomposed by treatment with hot water, when the solution of potassium carbonate is evaporated down.

Production of Chlorides of the Earthy Alkaline Metals from their Respective Sulphates.—B. Lach.—Whilst reducing heavy spar with carbon, the author passes hydrochloric gas over the ignited mass, obtaining at once barium chloride and sulphuretted hydrogen. The decomposition is said to be more complete and the working temperature lower than in the common process.

Improvements in the Manufacture of Gelatine and Glue.—A. J. Huet treats the animal matter for twenty-four hours with a solution of aluminium chloride at from 3° to 7° Tw., and leaves them in heaps till required. On boiling, the fat collects entirely on the surface, whilst in the common process with milk of lime from 5 to 7 per cent is wasted.

Improved Extraction-Apparatus with Cohobator (German Patent, 18,922).—V. Hänig and O. Reinhardt have devised an apparatus, which cannot be described without the appended diagram.

Combination of the Leblanc and the Ammonia-Soda Process with Simultaneous Recovery of the Sulphur and the Ammonia (German Patent No. 19,216).—Max Schaffner and W. Helbig.—The vat-waste obtained by Leblanc's process is treated with magnesium chloride according to Schaffner and Helbig's method for the recovery of sulphur. Magnesia is obtained. The excess of magnesium chloride is precipitated as magnesia by treatment with burnt lime or dolomite. This magnesia is employed for evolving ammonia from the sal-ammoniac lyes of the ammonia-soda process, reproducing magnesium chloride.

Preparation of Coatings for Protection against Rust.—A. Riegelmann prepares for this purpose alkaline mixtures.

Adulteration of Barium Sulpho-cyanide.—J. Tscherniac.—This compound, though so recently introduced into commerce, is already grossly adulterated. The author recommends to shake up a small quantity of the sample with two or three times its weight of absolute alcohol. The pure salt dissolves rapidly, whilst the impurities remain insoluble.

No. 52, September 10, 1882.

Detection of Strontianite.—Drs. Jehn and Wüsthoff.—A little of the mineral is dissolved in dilute nitric acid in a test-tube, the solution evaporated, and the crystals are treated with a mixture of equal volumes of ether and absolute alcohol. If all is dissolved nothing but calcite was present, but if the salt remains undissolved the sample is strontianite. The evaporation of a drop of the solution upon a watch-glass shows whether calcite is simultaneously present.

New Sewage Process.—A company has been formed at Liege for working the patent of M. Neujeun. This inventor proposes to purify sewage by filtering it through the basic slags of the Bessemer process which contain calcium phosphate. These slags are said to withdraw from the sewage the organic and especially the nitrogenous matter, as well as a part of the mineral impurities, whether dissolved or suspended. The slags are then converted into superphosphate by treatment with sulphuric acid. Analytical confirmation is wanting.

Formation of Nitric and Nitrous Acids.—Dr. S. Kappel.—The author has examined the presence of nitric acid in the solution of copper oxide in ammonia, and finds that the transformation of ammonia into nitric and nitrous acids in presence of copper and oxygen takes place in the cold, but is accelerated by heat. The same acceleration takes place in cold, in a current of carbonic acid. The oxidation of ammonia in presence of copper cannot be shown with certainty in the total absence of air. The copper may be replaced by zinc and iron, but their action is weaker than that of copper.

Formation of Ozone and Hydrogen Peroxide.—Dr. S. Kappel.—The author examines if fixed alkalies in contact with air and copper induce the generation of nitrous acid. He finds that on passing pure air through a pure alkaline solution in contact with copper, ozone and hydrogen peroxide are formed, but scarcely nitrites. These reactions take place in warmth only, and cease in cold weather, thus confirming the supposition that H_2O_2 is an endothermic compound. Metals which in contact with alkalies evolve hydrogen do not produce these formations, as the nascent hydrogen has a reducing action.

Certain Earths present in Cerite.—B. Brauner.—In order to revise the atomic weights and leading properties of the earthy metals contained in cerite, Brauner worked up about 3 kilos. cerite, and obtained 1380 grms. cerium oxide. After its separation the combined oxides were submitted to a long systematic series of fractionated precipitations with ammonia till all the portions more basic than didymium have been removed. The 58 grms. didymium oxide thus obtained were still not homogeneous. By repeated fractionation the last or least basic portion was isolated. By a double precipitation with potassium sulphate there was first obtained an earth of the atomic weight 149·2, or, after correction for a portion of didymium still present, $B''' = 150·7$. By the study of the absorption-spectrum it was shown that this fraction consists chiefly of samarium (or Yβ of Marignac), but as the atomic weight of Yβ according to Marignac is R''' 149·4, the possibility is not excluded that it occurs here in mixture with a second earth of a higher atomic weight. In the more soluble double sulphates of this fraction the presence of the following metals has been hitherto shown: Yttrium, by its spark spectrum, and erbium and holmium (Soret), by their absorption-spectra. As some portions of this fraction yield orange-coloured oxides the presence of terbium may be suspected. Hence there occur in cerite, in addition to the earthy metals, cerium, lanthanum, and didymium, at least six other elements of this group.

Non-existence of Pentathionic Acid.—W. Spring.—Already noticed.

Synthesis of Acids, Acetons, Aldehyds, and Glycocolls in the Aromatic Series.—E. Burcker.—The author by means of the synthetic method of Friedel and Crafts has obtained benzoyl-propionic acid, and benz-hydril-propionic acid.

Chemistry of the Nymphaceæ.—W. Grüning.—The author has obtained from the roots of *Nuphar luteum*, a new alkaloid, nupharine, $N_2C_{18}H_{24}O_2$. It is characterised by the following reaction:—If the sulphuric solution of nupharine is allowed to evaporate over sulphuric acid, in ten to twelve days the liquid takes a splendid green colour, which in ten days more passes into a deep greenish blue. If a few drops of water are added the colour immediately disappears, with formation of a yellow crystalline deposit.

Occurrence of Organic Bases in Commercial Amylic Alcohol.—L. Haidinger.—Amylic alcohol, even when sold as pure, generally contains bases, among which pyridine has been identified. This circumstance is of importance in proximate analysis as amylic alcohol is often used for the extraction of alkaloids.

Separation of Antimonic Acid from Antimony Oxide, and of Antimony and Tin.—Dr. A. Zeller.—Only antimonic acid, or the corresponding penta-chloride, has the property when in hydrochloric solution of separating 2 atoms iodine from potassium iodide for every atom of antimony. Stannic acid (or chloride) in an acid solution have no decomposing action upon potassium iodide. In this manner antimony and tin in alloys may be easily separated and determined.

Reactions of the Bile Pigments.—E. Capranica.—If 2 parts of bromine dissolved in 100 parts of alcohol are added by drops to a solution of bilirubine in chloroform or ether, the liquid becomes first emerald-green, then blue, violet, red, yellow, and finally colourless. The action of chloric and iodic acid is similar. The solutions of the yellow cells of the chloroidea and retina, of the yolk pigment, and the corpora lutea, are decolourised at once without a trace of green colouration.

Action of Wine upon Kaolin.—R. Kayser.—A proportion of 0·3 to 0·4 grm. alumina per litre is no proof of the presence of alum, since the acids of the wine may dissolve alumina from kaolin added as a clarifying agent, or from earthy dust adhering to the skins and stalks of the grapes.

New Colour Reactions of the Alkaloids.—Dr. C. Arnold.—(1) Coniine.—If a few drops of syrupy phosphoric acid are mixed with a drop of coniine, and the mixture is evaporated over a small flame in a white porcelain capsule, the mixture takes a fine green colour. (2) Nicotine, treated in the same manner, gives a deep yellow or orange colour. (3) Aconitine.—The known violet colour, on evaporating this base with phosphoric acid, is best obtained if a few particles are stirred up with some drops of syrupy phosphoric acid and heated for ten to fifteen minutes on the water-bath.

Cosmos Les Mondes.

No. 7, October 14, 1882.

Vanadium Green.—According to MM. Osmont and Witz, vanadic acid, on treatment with hydrochloric acid, gives a fine green colour, which may be at once employed in dyeing.

No. 8, October 21, 1882.

Nickel is proposed in France as a substitute for bronze in coinage. To prevent them from being mistaken for silver the pieces will be octagonal instead of round.

Properties of Antiseptics and the Volatile Products of Putrefaction.—G. Le Bon.—The disinfecting power of an antiseptic is so much the less as the putrefaction is of less recent origin. There is no parallelism between the disinfecting power of an antiseptic and its action upon microbia. Potassium permanganate, which is one of the most powerful disinfectants, has no appreciable action upon microbia. With alcohol the case is reversed. There is no parallelism between the power of hindering the production of putrefaction and that of arresting it when it has taken its rise. Alcohol and phenol, which are excellent preservatives, have but a very feeble action upon putrefaction when it is established. With the exception of a small number of formidable poisons, such as mercuric chloride, most of the antiseptics, and especially phenol, have little action on bacteria. There is no parallelism between the virulent power of a body in putrefaction and the toxic power of the volatile compounds which it gives off. These two properties even seem to bear an inverse relation to each other. The quantity of the products of advanced putrefaction necessary to kill an animal by simple admixture with the air which it breathes is very small, and proves that these volatile alkaloids are extremely poisonous. Hence the atmosphere of cemeteries may be extremely dangerous notwithstanding its poverty in microbia.

Silico-molybdates.—F. Parmentier.—The author has obtained a silico-molybdic acid by adding to an acid solution of a molybdate dialysed silica, or a silicate dissolved in an acid. The free acid is obtained by treating mercurous silico-molybdate, suspended in water with dilute hydrochlororic acid.

Rotatory Power of Tyrosine and Cystine.—Dr. J. Mauthet.—These two bodies are sinistro-rotatory, tyrosine feebly, but cystine energetically.

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Justus Liebig's Annalen der Chemie,
Band 215, Heft 1.

Synthesis of Pyridinoid Compounds from Acetacetic Ether and Aldehyd Ammonia.—Dr. A. Hantzsch.—A voluminous memoir, in which the author describes the preparation and properties of hydro-collidine dicarbonic ether; its halogen derivatives; its oxidation-product and its derivatives; the decomposition-products arising from the action of hydrochloric acid upon hydro-collidine dicarbonic ether, and finally the oxidation-products of collidine dicarbonic acid.

Communications from the Laboratory of Prof. V. Meyer, of Zurich.—These consist of Contributions to the Knowledge of the Fluoresceine Reaction, by Dr. E. Knecht, and a treatise by Dr. C. Langer on Uniformities in the Substitution of the Aromatic Amines.

Band 215, Heft 2.

Contributions to the Knowledge of the Quinones and Hydro-quinones.—R. Nietzki.—The author describes the preparation of quinone and hydro-quinone, the combinations of the quinones with the phenols and with phenoloid bodies, the nitro-derivatives of quinone and hydro-quinones, nitranilic acid, dinitro-hydro-quinone, the nitro-derivatives of di-ethyl-hydro-quinone, toluquinone, hydro-toluquinone, its methyl-ethers and their condensation-products, xylo-quinone, and hydro-xylo-quinone.

MISCELLANEOUS.

The Bread Reform League.—Our attention has been called to the above movement, which, it appears, enjoys the countenance of some of the first chemists and physiologists of the day. Its object is to bring into general use bread made from the entire grain of wheat, instead of from its inner portion only. Such a change, it is contended, would not only effect a saving of from 20 to 25 per cent of the money expended in the purchase of grain, but would be decidedly beneficial to health. It seems to us that the question is deserving of further investigation both chemical and physiological. Experiments on the comparative nutrient power of white bread and wheat-meal bread would, if made upon animals, probably expose the unfortunate investigator to the pains and penalties of the "Vivisection Act." But any man who can obtain the whole-meal bread—"grund-down" as it used to be called in the North—is at liberty to experiment upon himself. It is certain that such bread is a very different article from the brown bread commonly sold.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Fish Offal.—Will you kindly tell me what is the average chemical composition of fish offal, *i.e.*, heads and guts, when separated from the bodies? or name a good work on this subject?—F. G.

Specific Heats.—Would the abstractor of the proceedings of the Russian Chemical Society kindly inform me what numbers M. Diaconoff obtained for the specific heats and heats of vapourisation of normal propyl alcohol, amyl alcohol, and dimethyl-ethyl carbinol?—W. Ramsay.

MEETINGS FOR THE WEEK.

Saturday, 9th.—Physical, 3.
Monday, 11th.—Medical, 8.30.
—— London Institution, 5.
—— Society of Arts, 8. "Dynamo-electric Machinery," by Prof. Sylvanus P. Thompson, D.Sc.
Tuesday, 12th.—Institution of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.
—— Photographic, 8.
Wednesday, 13th.—Society of Arts, 8. "Electrical Exhibitions," by W. H. Preece, F.R.S.
—— Microscopical, 8.
Thursday, 14th.—Royal, 4.30.
—— Philosophical Club, 6.30.
—— London Institution, 7.

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SUPERPHOSPHATES.—Can any reader of the Chemical News furnish information respecting the production of Superphosphates of high percentage and free from arsenic compounds, where they can be obtained, and at what price?—Address "M. E. C. C.," care of Davies and Co., Advertising Agents, Finch Lane, Cornhill.

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NOTES ON THE DETECTION OF THE ACIDS (Inorganic and Organic) USUALLY MET WITH IN ANALYSIS. For the Use of Laboratory Students. By J. William James, Ph.D. (Jena), F.C.S. (Lond. and Ber.), Demonstrator and Lecturer in the Mining School, Bristol.

London: J. and A. CHURCHILL, 11, New Burlington Street.

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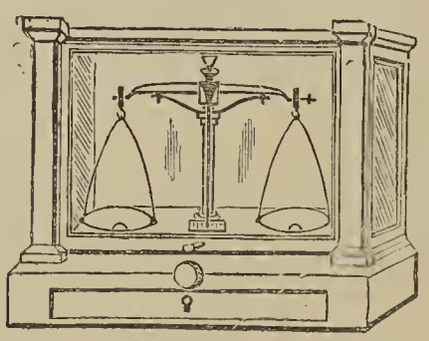
ROTTERDAM,  NEW YORK.

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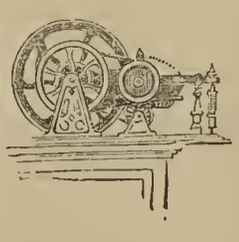

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THE CHEMICAL NEWS.

VOL. XLVI. No. 1203.

ON THE COMPARATIVE EFFECTS OF TWO METAMERIC BODIES ON THE GROWTH OF *NICOTIANA LONGIFLORA*.*

By J. EMERSON REYNOLDS, M.D., F.R.S.,
Professor of Chemistry, University of Dublin.

THE study of the comparative action of metameric compounds on the growth of plants seems to deserve more attention than it has yet received from chemists and vegetable physiologists, and the aim of the communication I now beg to lay before the Academy is to show that well-marked differences in physiological activity can be detected with the aid of plants, even in cases of metameric bodies of comparatively simple constitution.

The bodies selected for experiment were ammonium sulphocyanate and its metamer thiocarbamide, or sulphurea. Both compounds are rich in nitrogen, and therefore capable of supplying a highly important element of plant-food; they are easily soluble in water, and, consequently, admit of absorption through the roots of plants; moreover, their chemical relations have been carefully studied, and their differences of structure are known; hence they seemed to be very suitable for the class of work in which I proposed to employ them.

The sulphocyanate is a true ammonium salt of sulphocyanic acid, and its composition is represented by the formula—

$$NH'_4CNS'.$$

The metamer of this body, or thiocarmide, I discovered in 1869, and obtained in the following way:—

The salt was melted, and the temperature of the liquid raised to 170° C., when rearrangement of the components of the molecule took place; the mass, when cooled, extracted by water and crystallised, afforded fine crystals of thiocarbamide. This body contains the same elements as the sulphocyanate, and in the same proportions, and its molecular weight is the same; but its relations and chemical structure are very different, as it is a feeble base, and destitute of saline characters, while its relations are represented by the structural formula—

$$CS\begin{cases}NH_2\\NH_2\end{cases}.$$

During the summer of 1881 I made several sets of experiments with these bodies on selected groups of plants which are known to afford special nitrogenised or sulphuretted products, when grown under normal conditions. Some of the results obtained are sufficiently definite to justify their publication, while others require repetition under new conditions. In the present communication I shall confine myself to the statement of experiments made with a variety of the tobacco plant (*Nicotiana longiflora*). The seeds were obtained from Messrs. Veitch and Sons, and afforded a good crop of young plants, which were removed from the seed-bed, and potted singly in very sandy mountain loam, of rather poor quality, the aim being to give the plants no more nourishment than was absolutely necessary to ensure moderate development. When the plants were shifted into four-inch pots they were allowed to become thoroughly established, and the experiments commenced.

Several sets of three healthy plants were picked out, and the members of each set were as nearly as possible in the same stage of development, *i.e.*, they were of the same height, had an equal number of leaves, and equally strong stems. Each set was subjected to the same treatment, but it will conduce to clearness if I trace that of a single set.

The treatment pursued was the following:—

No. 1 was watered with Vartry water only, when necessary.

No. 2 was watered twice each week with a solution of 0·5 grm. of pure thiocarbamide in 250 c.c. of water; at other times it was treated as No. 1.

No. 3 was watered twice each week (unless otherwise stated) with a solution of 0·5 grm. of pure ammonium sulphocyanate in 250 c.c. of water.

The plants were under glass, but so placed as to get equal light, and to prevent any undue tendency to drawing up or "spindling."

The first to show any effects was No. 3 (*i.e.*, that treated with the sulphocyanate); at the third treatment with the solution the growth was checked, and the plant seemed not only to stop development, but even to shrink in a curious way: the leaves began to droop, and became rather sickly in colour. The fourth application only intensified the symptoms of plant-poisoning by the sulphocyanate; hence the treatment was stopped, and the soil well washed out by percolation of pure water. After this the plant recovered somewhat, and re-commenced growth; but it received another dose, which again checked development. Washing the soil was repeated, and another rest allowed. This treatment was continued for nearly three months, up to the 1st of December, when it presented a very miserable appearance, and was in the condition stated in the Table. This plant was then removed from the soil and dried.

There is no doubt that I could have killed this plant at any time by continued doses of the sulphocyanate, for corresponding plants of other sets so treated with the salt were destroyed in a few weeks.

No. 2 plant (*i.e.*, that treated with the solution of thiocarbamide) soon gave evidence that it felt the effect of its dose, but the result was very different from that observed in No. 3: the stem did not elongate much, but the leaves rapidly developed in length, breadth, add substance, and assumed a healthy deep green hue. It was noticed, however, that the development was less satisfactory where the solution of thiocarbamide was alone used for watering than where there was a washing of the soil with pure water between two doses; in the former case the edges of the lower leaves becoming discoloured and thin. The reason for this is not far to seek, for the thiocarbamide is known to undergo partial re-conversion into sulphocyanate in aqueous solution, and more especially in presence of such decomposable bodies as are found in the soil. The check in development of the plant doubtless followed this partial reversion.

With the slight modification in the treatment just referred to the plant developed remarkably, until, on the 1st December, it was in the state described below.

No. 1 plant (*i.e.*, that treated with plain water) grew rapidly, and soon outstripped the others in height, but its stem and leaves were poor and thin as compared with No. 2.

The following table contains the measurements, &c., of the plants on the 1st of December:—

	No. 1 (Water).	No. 2 (Thiocarbamide).	No. 3 (Sulphocyanate.)
Total height in inches from surface of soil	31	23	12
Number of leaves..	15	14	13
Maximum length of leaf in inches..	9½	15¼	8
Maximum breadth of leaf in inches..	4¼	6	2½
Number of seed pods in different stages of develpmnt.	9	15	none
Number of seed pods well developed	1	11	none

* Read before the Royal Academy, April 10, 1882; and reprinted from the *Proceedings*, 2nd series, vol. iii. (Science), No. 9, December, 1882. Communicated by the Author.

Corresponding results were obtained with the other sets of tobacco plants.

The next step would obviously be the determination of the relative proportions of nicotine derivable from the plants, but the amount of material at my disposal proved insufficient for the purpose. I hope, however, to be able to grow a considerable quantity during the ensuing summer, and to repeat the experiments.

The facts ascertained are, however, amply sufficient to prove that ammonium sulphocyanate acts as a powerful poison on these plants, notwithstanding the large proportion of ready-formed ammonia it contains, while its metamer thiocarbamide stimulates the growth of similar plants, and induces healthy development of all their parts, thus acting as a distinct plant food. Indeed, if it were not that thiocarbamide tends to revert to the sulphocyanate after some time, the former might be regarded as a good organic manure for tobacco.

I must leave to the vegetable physiologist the task of determining the precise way in which nutrition is arrested by the sulphocyanate and promoted by thiocarbamide: for the present I am content to have shown that their effects on the particular plants employed are widely different, though the bodies compared contain the same elements chemically united, in the same proportions within molecules of the same weight. The conclusion is inevitable that their strongly contrasted physiological action is due to diverse molecular structure. We thus learn—

1st.—That the particular elements of which the bodies are composed exerted less influence on their physiological activity than the intra-molecular grouping of the component atoms.

2nd.—That, in some instances at least, differences of physiological activity between metameric bodies can be easily detected with the aid of plants.

ESTIMATION OF SULPHUR IN IRON AND STEEL.

By GEORGE CRAIG.

In Mr. Rocholl's criticism on my communication on the above subject (Chemical News, vol. xlvi., p. 236) he unjustly ridicules the process I employed to detect sulphur in the residues—because I did not find any—and negatives my conclusion that even cupriferous irons may be made to yield all their sulphur on treatment with hydrochloric acid—because he cannot get it all off. Unscientific reasoning like that needs no comment.

Now it would be a pity were the oxidation processes (by which I believe the bulk of the sulphur determinations are made) incapable of estimating, according to Mr. Rocholl's experiments, sulphur varying from 0·004 per cent to 0·37 per cent (or 0·04 per cent to 0·27 per cent $BaSO_4$)—the latter is about the amount obtained from good pig-iron; and the smaller quantity, which from its insignificance could be practically ignored, can easily be estimated in solutions containing such large quantities of KCl and $FeCl_3$ as Mr. Rocholl states (evidently he has never tried it) would certainly prevent the precipitation of either. All I need say on this point is that if sufficient of a dilute solution of Epsom salts, to contain 0·004 per cent S or even 0·002, be added to such a solution of iron along with a little $BaCl_2$, and after standing for twelve hours, on gently rotating the contents of the flask a small precipitate of $BaSO_4$ will gather at the vortex, and if weighed will be almost the same as that obtained from a similar quantity of the solution of Epsom salts. The chief, if not the only, constituent in such a solution which exerts an interfering action on the precipitation is, I believe, the amount of free acid present.

In a few of the residues from the evolution process I did obtain, after standing forty-eight hours, minute precipitates which would not give any more than 0·002 per cent sulphur, and the only one I thought worth while estimating was that from a siliceous iron, noticed in my communication to Chemical News, and which only weighed 0·5 grain. As I only obtained these precipitates occasionally, and being so minute I considered they might be attributable to a variety of causes—temporary impurity of the gas used for evaporation, presence of a little SO_2 or H_2S in the laboratory atmosphere—and as it was of no practical consequence whether they belonged to the iron under examination or not, I ignored them. In support of my conclusion that all the sulphur may be evolved on treatment with HCl, and to give recent experiments only, performed since reading Mr. Rocholl's criticism, I made a cupriferous iron containing 0·50 per cent copper, three determinations of sulphur in 100 grains of which by the (H_2O_2) evolution process gave $BaSO_4$ 0·52, 0·54, and 0·53 grain.

The residues were filtered, excess of $KClO_3$ (50 grains) added to filtrate, and evaporated with a little additional HCl to prevent the precipitation of basic iron salts, till about to solidify, diluted, filtered, made up to about 20 ozs., $BaCl_2$ added, and after standing twenty-four hours there was no precipitate in any of them.

The insoluble portion of the residue from the experiment yielding 0·52 $BaSO_4$ was washed into a basin, and to another basin was added an equal quantity of water, and both evaporated over contiguous argands to dryness; ½ oz. HNO_3 added to each evaporated almost to dryness; ½ oz. HCl added to each, and again evaporated almost to dryness. The evaporations were performed almost simultaneously, and occupied the same time, so that the contents of each basin had the same chance of absorbing sulphur compounds from the burnt gas of the argands or from the laboratory atmosphere. A little water was added to each, heated, filtered, and made up to 4 ozs., $BaCl_2$ added, and after standing twelve hours, the precipitates, which apparently were about equal, were filtered, washed, ignited, and weighed. That from the residue, which was slightly reddish from containing a little Fe_2O_3, weighed 0·045 grain, while the blank experiment gave 0·040 grain. This, which would indicate not even a trace of sulphur in the residue, is the method employed by Mr. Rocholl himself, and by which he gets precipitates varying from 0·04 to 0·27 per cent.

The insoluble portions of the residues from the other two experiments were each with their containing filters thrust into a deep platinum crucible, 50 grains KNO_3 and 30 grains Na_2CO_3 added, and the moist mass mixed well with a glass rod, dried in water-bath detached from crucible, which was heated in a small chimney (to prevent access of the products of combustion to the contents of the crucible) to redness over the blowpipe, and the mixture injected in convenient quantities at a time and completely fused, the operation occupying about three minutes; the contents of the crucibles dissolved in water, acidified slightly with HCl, and evaporated gently to dryness, a few drops HCl added, heated with a little water, filtered up to 5 ozs., and $BaCl_2$ added.

A filter, washed with dilute HCl, was subjected to identically the same treatment; and after the three solutions had stood overnight, the small precipitates (those from the residues being apparently the larger) were filtered, &c. The $BaSO_4$ from the residues weighed respectively 0·030 and 0·040 grain, while from the blank experiment it weighed 0·015 grain.

This would yield 0·002 and 0·003 per cent sulphur, and these precipitates were brownish from containing a little Fe_2O_3, and should be manifestly a little less. I fused the combined precipitates with a grain of Na_2CO_3 in the crucible in which they were ignited, decomposed with a drop or two of HCl heated, diluted to 1 oz. bulk, added a drop of $BaCl_2$, and filtered after standing six hours, when they weighed 0·05, which after proportioning and deducting blank experiment gives about 0·001 and 0·002 per cent S, which is of no consequence, as is also the larger num-

bers obtained from the impure precipitates. It would seem as if this small amount of sulphur was not in combination with the copper at all (else I should have obtained it by Mr. Rocholl's method), but probably in some way with the carbon.

Tabulating these results give :—

	Cu in Pig-iron.	S evolved.	Sulphur in Residue. Liquid.	Solid.	Prcntge. of S evolved.
I.	0·50	0·063	nil	nil*	100·0
II.	do.	0·065	nil	maxim. 0·002†	97·0
III.	do.	0·064	nil	do. 0·003†	95·4

* Mr. Rocholl's process. † Fusion process.

Surely there must be some radical difference in the manner in which Mr. Rocholl and myself work the details of the evolution process when we obtain such diverse results, the one getting often only 50 per cent of the sulphur and the other practically 100 per cent. On reading over my communication as it appeared in the CHEMICAL NEWS I notice one point that I did not give due prominence to, and which may account for the above difference, and that is the length of time during which the solution is gently boiled after the evolution of gas has become sluggish : I give it from fifteen to twenty minutes.

The composition of the pig-iron has nothing to do with it, as I have tested Middlesbrough brands by the process, also Bessemer irons and white irons containing 0·5 p.c. S, the residue from the latter being absolutely free from even traces of sulphur when tested by the oxidation process described. With steels the process works even better than with pig-iron ; and the only case I have met with in which the sulphur could not be estimated by it was that of a siliceous spiegel containing 20 per cent manganese and 10 per cent of silicon.

Lugar Iron Works, Dec. 4, 1882.

PYROLOGICAL NOTES.

By Lieut.-Colonel W. A. ROSS, late R.A.

(Continued from page 249.)

VI. ON THE USE OF BORIC ACID AS A REAGENT. (*Continued.*)

Detection of Alumina by means of Lime.—Another secondary result, of still greater importance than the gelatinisation of aluminoid alkaline silicates (previously described), is shown by the following experiment :—

If we add the powder of a calcium silicate containing no alumina, such as *Wollastonite*, to boric acid under O.P., we obtain a bead transparent or translucent according to the proportion of combined water in the mineral, which causes a kind of grey opalescence on cooling, the bead being perfectly clear hot. Through this semi-opalescent matter are distinctly observed, by means of one of the American lenses now sold in London for a shilling,—(*a*) transparent balls of calcium borate, but covered with curious, apparently crystalline, marks. (Calcium silicate : about two years ago I discovered by means of a powerful microscope, then first applied to these reactions, that these "marks" were in reality transparent *inner* balls, to be described hereafter). These calcium borate balls are generally a pale green colour when cold (easily observed on account of the semi-opalescent matter round them) due to iron protoxide, from the trace of iron present (0·40, Stromeyer), which is *invariably* seized upon and dissolved by the calcium borate ; a large proportion of iron oxide being shown by separate brown-black opaque balls. (*b*) Free silica, in the shape of semi-transparent, sharp, unattacked fragments. These, and all pyrological contents of boric acid, can be boiled out of the bead and obtained on a filter for weighing.

Now let us add the powder of another calcium silicate, but containing alumina, such as *Zoisite*, to a fresh boric acid bead under O.P. How different is the result obtained ! The bead is, almost immediately, milk-white and quite opaque, just like a little bit of the white enamel used by jewellers. I at once suspected that this must be due to the decomposition by the alumina of the transparent calcium borate balls, and the precipitation and diffusion of the white finely-divided lime throughout the bead. This was proved to be the case by the careful solution of alumina to opaque saturation in a boric acid bead, by means of the addition of carbonate of potassium O.P., when only a *grey* opaque bead was procured. The fact was also confirmed by application of the microscope, when the balls were preserved and seen in the very act of decomposition. Thus, the smallest trace of alumina present in an aluminium silicate may be detected by simply adding to the boric acid bead containing it, a *proportionate quantity* of lime-powder before the blowpipe, when the calcium borate balls are at once decomposed by the alumina, and "milkiness" ensues.

To those chemists and pyrologists who know the inefficiency of Gahn's (very beautiful) blowpipe test for alumina by means of cobalt solution, which is absolutely useless when metallic oxides are present, this delicate reaction, by which 0·005 of combined alumina can be detected, must prove a real boon : at all events, Mr. Wanklyn, to whom I showed the above experiment some three years since, thinks so.

For instance, in the case of the "transparent, ice-like mass or jelly" given by the treatment of "zeolite" powder in boric acid, as above described, we have but to add to the bead under O.P. a trace of lime-powder to see (by the 'milkiness" produced) if only a trace of alumina is present: more lime produces more milkiness, and so on, until we find, by the quantity of lime added, precisely the quantity of alumina present. The same phenomenon happens if the alumina is previously present in the boric acid bead in the shape of white opaque fragments, whether combined with silica or not, but apparently (for I am not clear on the subject yet) alumina added to a boric acid bead *after* lime is in possesuion of its borate has no effect in decomposing *it*. If there is no alumina in the assay, the added lime is *transparently* dissolved by the alkali present.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 7, 1882.

Dr. GILBERT, F.R.S., President, in the Chair.

THE following certificates were read for the first time :—G. Chandra Basu, W. R. Flett, E. C. Gill, J. Hunter, T. Jenner, W. W. J. Nicol, F. W. Richardson, E. S. Spencer, C. A. Serre.

During the evening a ballot was held and the Scrutators, Messrs. Greenaway and Kingzett, declared the following gentlemen to be duly elected Fellows of the Society :—J. S. Bishop, E. E. Berry, F. W. Bransom, R. Blair, T. R. Cowie, R. Carruthers, R. Coulthard, W. J. Chrystal, E. G. Clayton, J. T. Dunn, H. L. Dampier, A. G. Earl, G. Gray, A. G. Howard, W. A. L. Hammersley, J. L. Howe, H. Hotblack, A. E. Johnson, E. Jackson, A. Keen, J. Kilner, J. D. McCarthy, H. C. Newton, S. C. Phillips, R. H. Parker, T. F. Peppe, S. Rideal, G. M. Taylor, T. E. Vasey.

The two following papers were read by the SECRETARY :—

"*On the Condensation-Products of Œnanthol*," by W. H. PERKIN, Junr. Much work has been already done on the condensation-products of iso-butyric, iso-valeric, and œnanthylic aldehyds, but in many cases only the formulæ of the products obtained have been given : the author

therefore undertook the present research to obtain, if possible, some clue as to the constitution of the bodies formed, especially from œanthol. In the first section of the paper the action of alcoholic potash on œnanthol is noticed. Dilute potash was used, and two acids were found (heptylic acid and an acid, $C_{14}H_{26}O_2$, boiling between 270° and 290°) in combination with the potash. From the oily condensation-products two bodies were isolated, the principal one being an aldehyd, $C_{14}H_{26}O$,—a colourless oil, boiling at 277° to 279°. The second condensation-product is a thick, light yellow oil, with disagreeable smell and burning taste, boiling at 330° to 340°; it was probably an aldehyd, having the composition $C_{28}H_{50}O$. The second section of the paper refers to the action of zinc chloride on œanthol. The reaction is violent. The œanthol was agitated with water, and a very small quantity of zinc chloride used. The principal product is again the body $C_{14}H_{26}O$. The action of acetic anhydride on the aldehyd, $C_{14}H_{26}O$, is then examined; it acts simply as a dehydrating agent, $2C_{14}H_{26}O = C_{28}H_{50}O + H_2O$. On fusing this substance, $C_{28}H_{50}O$, with caustic potash, heptylic and hexylic acids were formed. Nascent hydrogen converts the body $C_{14}H_{26}O$ into an alcohol, $C_{14}H_{28}O$, boiling at 280° to 283°; it is not a saturated body, and by the further action of nascent hydrogen it is converted into another alcohol, $C_{14}H_{30}O$, boiling at 270° to 275°. The author then studied the oxidation of the body $C_{14}H_{26}O$; heptylic and hexylic acids were the chief products. Small quantities of an acid with a high boiling-point were produced, which probably had the composition, $C_{14}H_{26}O_2$. Alcoholic potash acts upon $C_{14}H_{26}O$, forming heptylic acid and an acid, $C_{14}H_{26}O_2$, boiling at 275° to 280°. From a general consideration of the various reactions, the author concludes that this body, $C_{14}H_{26}O$, has the constitution—

$$\begin{aligned} &CH_3-(CH_2)_5-CH \\ &\qquad\qquad\quad \| \\ &CH_3-(CH_2)_4-C\text{--}COH \end{aligned}$$

or hexyl-pentyl-acrylic aldehyd.

"*On the Condensation-Produets of Isobutyl-aldehyd*," by W. H. Perkin, Junr. A short time since there appeared in the *Beriehte* an abstract of a preliminary notice of Fossek from the *Monatschrift der Chemie*, on the action of an aqueous solution of caustic potash on isobutyl-aldehyd. As the author has for some time been working on these condensation-products, he felt himself compelled to publish his results, although at present not quite complete, especially as they are quite different from those obtained by Fossek. The action of alcoholic potash seems to be quite distinct from that of aqueous potash. The author first describes his method of preparing the isobutyl-aldehyd. 50 grms. of this substance are first diluted with 100 c.c. of absolute alcohol, and 40 c.c. of a 10 per cent solution of alcoholic potash slowly added, the temperature never being allowed to rise above 30°. After standing twelve hours the mixture is warmed to 50° for a few minutes, and then left to cool. The potash solution contained isobutyric acid and a new acid, $C_{12}H_{22}O_3$, boiling at 245° to 255°; distilling without decomposition; not sodifying at −10°. Fossek with aqueous potash obtained an acid melting at 75°, with composition $C_8H_{16}O_3$. The oily product of the above reaction after fractionation gave a distillate boiling between 154° and 157°, having the formula $C_{12}H_{22}O_2$. Much residue of a higher boiling-point was left in the retort. Fossek, by the action of aqueous sodic acetate on isobutyric aldehyd, obtained a body $C_8H_{14}O$. By the action of nascent hydrogen on the aldehyd $C_{12}H_{22}O_2$, an alcohol, $C_{12}H_{24}O_2$, was formed, boiling at 170° to 175°; it is a colourless oil which does not solidify at −10°; it has the same formula as ethyl-propyl-pinakone, but a different boiling-point. This alcohol, when treated with acetic anhydride, gives a diacetate, $C_{16}H_{30}O_4$. A vapour-density determination gave numbers about one-half of those required by theory. The higher condensation-products of isobutyl-aldehyd were next studied by using twice the above-mentioned quantity of alcoholic potash, and heating the mixture nearly to the boiling-point for ten minutes. Oily products were separated, which contained small quantities of the bodies $C_{12}H_{22}O_2$ and $C_{16}H_{30}O_3$, but the principal portion distilled over at 223° to 225°, and had the composition $C_{20}H_{38}O_4$; it is apparently an aldehyd; a vapour-density determination gave about half the calculated density. By the action of acetic anhydride a mono- and a di-acetate were formed. After this body $C_{20}H_{38}O_4$ had been distilled off, a body boiling at 250° to 255° was obtained, having the composition $C_{24}H_{44}O_4$. Another body boiling under 100 m m. pressure at 227° to 229° had the formula $C_{28}H_{48}O_3$.

Dr. Japp then read a paper "*On a Condensation-Product of Phenanthraquinon with Ethylic Aceto-acetate*," by F. R. Japp and F. W. Streatfeild. By heating a mixture of phenanthraquinon and ethylic aceto-acetate with a solution of caustic potash, the authors obtained a condensation-product of the formula $C_{20}H_{16}O_4$, crystallising from benzene in white silky needles, fusing at 185°. They ascribe to it the constitution—

$$\begin{aligned} &C_6H_4-C=C\begin{cases} CO-CH_3 \\ COOC_2H_5 \end{cases} \\ &\quad\ |\quad\ | \\ &C_6H_4-CO \end{aligned}$$

and the name ethylylic phenanthroxylene aceto-acetate. By treatment with fuming hydriodic acid in the cold this compound parts with one atom of oxygen, and is converted into ethylic phenanthroxylene iso-crotonate—

$$\begin{aligned} &C_6H_4-C=C\begin{cases} CH=CH_2 \\ COOC_2H_5 \end{cases} \\ &\quad\ |\quad\ | \\ &C_6H_4-CO \end{aligned}$$

which is deposited from light petroleum in groups of colourless crystals, fusing at 124°. This compound dissolves in dilute caustic potash on warming, and on acidifying with hydrochloric acid a new acid is precipitated, which by re-crystallisation from boiling phenol is obtained in short colourless needles, fusing at 295°. This acid is formed from the preceding compound by replacement of the ethyl group by hydrogen, and simultaneous assumption of the elements of water. The formula is therefore $C_{18}H_{14}O_4$. An examination of its salts showed that it was dibasic. The authors assign to it the constitution—

$$\begin{aligned} &C_6H_4-CH=C\begin{cases} CH=CH_2 \\ COOH \end{cases} \\ &\quad\ |\quad\ | \\ &C_6H_4-COOH \end{aligned}$$

Both the reduction-product and the dibasic acid derived from it yield, on destructive sublimation, long colourless needles of a new compound fusing at 213°, which gave on analysis figures agreeing with the formula $C_{14}H_{10}O$. The authors suggest that this compound may be the desoxybenzoin of phenanthrene,—

$$\begin{aligned} &C_6H_4-CH_2 \\ &\quad\ |\quad\ | \\ &C_6H_4-CO \end{aligned}$$

but the quantity obtained was insufficient for further investigation.

Dr. Armstong then gave a short communication "*On the Constitution of Lophin.*" This was a criticism of Dr. Japp's paper read at the last meeting. The author claimed that Radziszewsky's formula, and especially his own modification of it,—

$$\begin{aligned} &Ph-C-N \\ &\quad\ \| \quad\ \diagdown \\ &Ph-C-N \quad\ \diagup CHPh, \end{aligned}$$

was applicable in explanation of the reactions of lophin. He objected to Dr. Japp's use of the argument from analogy on the ground that the bodies obtained by the action of aldehyds on phenanthraquinon were not analogues of lophin, and he urged that since, in the great

majority of cases in which aldehyds enter into reaction with other bodies, the radicle CHR of the aldehyd remains intact, the argument from analogy would lead us to prefer the symmetrical rather than the unsymmetrical formula adopted by Dr. Japp. The formation of benzamide and dibenzamide on the oxidation of lophin, it was pointed out, is not difficult to explain, and the production of benzoic acid on heating lophin with hydriodic and hydrochloric acids is probably a consequence of a purely hydrolytic action. Incidentally Dr. Armstrong objected to Dr. Japp's use of the term "intra-molecular change" in cases involving no transposition of atoms.

Dr. Japp briefly replied to the criticisms of Dr. Armstrong, and reiterated his conviction that the formula proposed by him agreed best with the known decompositions, &c., of lophin, and he failed to see how Radziszewski's formula accounted for some of the known reactions of that body.

Mr. S. U. Pickering then read a paper "*On the Constitution of Molecular Compounds: The Molecular Weight of Basic Ferric Sulphate.*" Two methods of notation are commonly employed to represent basic compounds. Thus, with ferric sulphate, $2Fe_2O_3SO_3$, or $Fe_2(SO_4)_35Fe_2O_3$. In this latter an analogy between a basic salt and a hydrated salt is hinted at. If the first formula is correct, the molecular weight is 400; if the latter, m w. = 1200. The author has in the present paper endeavoured to determine the molecular weight of basic ferric sulphate by ascertaining the unit of water removable from a hydrated specimen of it. The author gives details as to the preparation of the sulphate, the hydration of it, and the loss of water under different conditions. If the molecular weight be 1200, 33 different hydrates are possible. He obtained 14 hydrates, all of which indicate the number 1200, and he concludes that it is practically a certainty that the molecular weight of basic ferric sulphate is 1200, and its formula $Fe_2(SO_4)_3,5Fe_2O_3$.

Mr. Toms then read a paper "*On the Chemistry of Hay and 'Ensilage.'*" The author has analysed various samples of hay, and contrasted them with analyses of "ensilage," *i.e.*, grass buried whilst green in a water-tight pit or "silo," and subjected to pressure. It is well-known to chemists that hay-making is not a mere drying of grass, but that a fermentation also takes place, which develops the well-know perfume of hay, and during which the grass loses its green colour. A specimen of good hay dried contained—

Fatty matters	2·17
Free acetic acid	1·89
Sugar	3·42
Starch	12·46
Gum and mucilage	27·25

A specimen of brown hay from the same rick as the last, but from a portion of the stack which had heated, contained—

Fatty matters	4·26
Aldehyd which formed a mirror with ammonio-silver nitrate	trace
Free acetic acid	5·38
Sugar	6·94
Starch	3·42
Gum and mucilage	24·77

More than two-thirds of the starch had thus disappeared, and apparently had been converted into sugar, &c. Three specimens of ensilage were examined. One differed very little from ordinary grass. The second was brown, and smelt strongly of tobacco: it contained more acetic acid and sugar, but less starch. The third specimen represented fodder which had been buried eighteen months: it still contains starch-sugar, but was not acid, and was mouldy.

Mr. O'Sullivan did not think that the author had proved the presence of starch in the hay and ensilage, because other substances, such as gum and mucilage, when boiled with dilute sulphuric acid, furnished cupric oxide reducing substances.

Dr. Gilbert said during his recent visit to America he had heard a good deal about "ensilage," and the process seemed to be thought much of in that country. The crops, too, of succulent maize, &c., seemed well suited for it. It was essential for a good result to put all the materials as quickly as possible in the "silo," and put on a pressure of 100 to 150 lbs. per square foot almost immediately. He suggested that unless samples of ensilage taken for analysis were kept under pressure during transit the product might be completely changed. The process was very suitable for the preservation of the pulp from the sugar-beet.

The Secretary then read a paper "*On certain Brominated Carbon Compounds obtained in the Manufacture of Bromine*," by S. Dyson. The author has separated from a liquor obtained as a by-product at the North British Chemical Company's Works, carbon tetrabromide, bromoform, and chloro-bromoform. These substances were identified by analysis, boiling-point, and vapour-density determinations.

Mr. W. H. Perkin then read a "*Note on the Preparation of Diphenylene Ketone Ether.*" A quantity of salicylic acid was heated with acetic anhydride, the mixture was boiled, and the excess of acetic anhydride distilled off. The residue, consisting chiefly of salicylide, was distilled, and an oily product came over, which solidified to a crystalline mass. On purification pale yellow needles were obtained, having the composition $C_{13}H_8O_2$, fusing at 170°. The yield is 30 to 40 per cent. The author's son, Mr. A. G. Perkin, is engaged in a study of the derivatives, &c, of this substance.

The Society then adjourned to December 21st.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, December 4, 1882.

George Busk, Esq., F.R.S., Treasurer and Vice-President, in the Chair

Acheson George Bartley, M.D., M.A., David Edward Hughes, F.R.S., George Law, F.R.G.S., F.Z.S., were elected members of the Royal Institution.

Five candidates for membership were proposed for election.

The presents received since the last meeting were laid on the table, and the thanks of the members returned for the same.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, October 26, 1882.

Mr. John Pattinson in the Chair.

Mr. B. S. Proctor's Inaugural Address.

(Concluded from p. 265).

Assuming that all bodies are endowed with molecular movements, and that their disposition to unite depends upon the harmony of these movements, we may naturally conclude that chemical change will be facilitated by change of temperature. It has been a common saying that heat was promotive of chemical change, but that is a one-sided statement, true only in relation to certain degrees of heat. If we were inhabitants of the sun, or some other very hot place, we might note that chemical action was promoted by a reduction of temperature, and that few combinations could be produced without it. The fact is, while a low temperature usually adds to the stability of a compound, when once formed, a high heat prevents the majority of combinations taking place. The aqueous zone—that is, the temperature between the freezing- and boiling-points

of water—is the fertile land of chemical change; here combinations and decompositions in infinite variety take place.

It being admitted that the contact of one body will communicate to others of a different temperature some of its molecular movements,—that harmony of these movements causes combination, and want of harmony causes separation,—it is not unnatural that the presence of one body may cause sympathetic vibration in another of the same temperature, but of different normal velocity of vibration, and thus bring about combination or decomposition in the manner long known as catalysis. The surface action of charcoal and spongy platinum affecting the union of H and O is probably of this nature, and the reverse of the way heat effects the same. The latter increasing the molecular movements till they come into harmony, the former retarding them till another harmony, a different chord, produces a like result. The doctrine of catalysis is going out of favour. Fermentation was formerly spoken of as a catalytic process,—then it was attributed to the force of vegetable life; but to call it vital force instead of catalytic is only moving the difficulty from one place to another, not getting rid of it. There is too much disposition to get difficulties put a little further away, just out of sight for the time being, and then neglecting them; such, for instance, as the recent endeavour to explain the process of digestion by saying that solution of the food in the stomach is principally due to the action of the living vibrios which always abound under these circumstances, and omitting to explain at the same time what aids the digestion in the stomachs of the vibrios; perhaps they have no stomachs, so the difficulty of explaining their digestion disappears. There are, however, a number of cases in which the presence of one body affects the chemical action of another, where we have not the opportunity of hiding our ignorance under the statement that the phenomena are due to vital force:—The decomposition of peroxide of hydrogen by oxide of silver; the more ready decomposition of chlorate of potash when mixed with oxide of manganese; the decomposition of chlorate of silver into chloride and oxygen by the action of nitric acid; the increased explosiveness of fire-damp in the presence of non-combustible dust, such as calcined magnesia; the solubility of platinum in nitric acid, if first alloyed with a large proportion of silver; and many other cases which will readily occur to you. In some of these there is probably no explanation more ready or more rational than the supposition that the contact of one body influences the motions of the others, and by this means influences their tendencies to combine or separate.

Johnstone Stoney, in the *Philosophical Magazine*, vol. 36, p. 134, estimates the velocity of the oxygen molecules. The pressure of the gas on its containing vessel equals its weight multiplied by the velocity of its molecules. He goes on to say if oxygen be replaced by hydrogen, which has only $\frac{1}{16}$ of the weight under the same pressure, the velocity must be square 16 (16^2) times as great, that is 250 to 1, to account for the same pressure. Feeling conscious of my own deficiency in mathematical training and experience, it is with some hesitation that I criticise this latter statement. If the momentum of O equals 16, that of H at the same velocity equals 1. At 4 times the velocity it equals 4 for each impact; but at 4 times the velocity it makes 4 times the number of impacts in an equal time, and so brings up the resultant force to 16. The force being proportionate to the *square root* of the velocity instead of the square. This velocity is that of the molecule through space from one part of the vessel to another, however small the movement may be, but the internal molecular movements are more regular and minute, and more ready to act upon the waves of light, causing bright spectral lines or absorption lines. The regularity of the motion is shown by the *narrowness* of the spectrum lines; and the complexity of the motion, by the number of lines belonging to any gas, by how many different velocities of undulations are interfered with, and how sharply the interference is limited. He quotes Maxwell to the effect that the free path of a molecule of air equals 7 "eighth metres." That is, a molecule of air between its collisions, moves on the average $\frac{7}{10^7}$ (7—one hundred millionths) of a metre, that is $\frac{1}{9}$th of the wave-length of the ray D.

The molecule is deflected 7×10^9 (seven thousand million times) in a second, and each free path lasts $\frac{14}{10^{11}}$ (fourteen thousand millionths) of a second. This is 50,000 times the double vibration of a red ray, and 100,000 times the double vibration of a violet ray. All the molecular motions affecting light must, Stoney says, vary in velocity only between these limits.

Clausius estimates that the mean distance between the molecules of a gas equal about $\frac{1}{10}$ of the length of their free path. Stoney concludes from Maxwell's experiments that the normal distance is probably about $\frac{1}{10^8}$ (one thousand millionth of a) metre, consequently there are about 10^{18} (a trillion) molecules in a cubic m.m. of gas. These statements, and such as these, may be regarded as knowledge in the nascent state, knowledge which scarcely yet exists, but which is to be. We have been taught that heat is a greater promoter of chemical change, but the greater part of the chemical processes with which we are acquainted can only take place at moderate temperatures, that is between the freezing and the boiling-points of water. The vital zone of temperature bears a luxurious growth of chemicals. The zone higher is characterised by decomposition and dissociation, the lower zone by stability of compounds, and the formation of some which are easily decomposed by heat.

In physical conditions also the middle or liquid state is the zone of chemical activity: it is here that molecular movements are sufficiently active to facilitate change, and yet kept within the bounds in which the motions of heterogeneous atoms have a probable chance of harmonising.

Hardness is a physical obstacle to the act of combination in solids, elasticity equally so in the case of gases, though neither of these objects are insuperable. Increased temperature (and consequent increased elasticity) facilitates the combination of some gases, probably by bringing their molecular movements into harmony with one another. If an equal number of vibrations per second be added to the motions of two inharmonious musical strings, a point may be reached at which they harmonise. If one string vibrates 45 times, while the other vibrates 95, they will produce a discord, but if we add five vibrations to each, making 50 and 100 respectively, the one will sound the octave above the other. An analogous action may enable the movements of two uncombined gases to become so harmonious as to result in their union. The compound motion resulting would then be constant in its character, unless the action of heat be increased so much that dissociation ensues, which would take place if the motion of one of the atoms was acted on by a rhythmical heat vibration, which would so far enlarge its orbit as to set it flying off from its companion atom.

The harmony of vibration may be brought about by other agencies than heat or light, such as pressure; increased pressure tending to combine sulphur and copper—reduced pressure facilitating the union of oxygen and phosphorus.

The molecular motion of a compound is probably the result of the composition of the forces of the molecular movements of its elements, but it is not probable that it is so in the simple mechanical sense in which we represent the composition of two forces as the diagonal of their parallelogram; the elements no doubt retain some of their individuality. Professor Mills, of Glasgow, objects to our saying that water contains H_2O (*Phil. Mag.*, Jan., 1876). He prefers to say that water plus energy equals H + O; and that H + O forms water plus energy. He thinks we might with equal exactness say that water is a simple body intermediate between H and O. If matter were only directed motion as he suggests, the compound water might be only compound in the same sense as the diagonal

is a compound in a paralellogram of forces, a simple line intermediate between the two forces H and O, but the conception of motion or force without matter seems to me to require a new definition of matter, or else to require the resolution of both force and matter into motion of luminiferous ether, the existence of which is hypothetical, and the nature of which we assume to be any that suits the requirements of our hypotheses. Had water been a force or motion as simple in its nature as the diagonal in a parallelogram of force, or as any simple force resulting from the combination of two forces acting in different directions, it would not necessarily be resolvable only into the two forces from the union of which it resulted. The fact that no application of force, varying in kind or quantity, has resulted in the production of anything but H and O from water supports the view of the elements of water retaining their individuality, to some extent at any rate, while in combination, and does not encourage us to regard Aq as a simple body or a simple force intermediate between H and O.

In Ag_2O the union is feeble because the normal movements of the elements are not closely harmonious. In H_2O the union is stable because of a closer harmony. In H_2O_2 the second equivalent of O is feebly held, because the normal movement of O is not closely harmonious with that of H_2O. And Ag_2O, we may suppose, decomposes H_2O_2 because of the harmony between the loosely attached oxygen atoms, continuing in their combination, and because the polarities of these atoms are not better satisfied by association with silver or water than they are by the union of two atoms of oxygen into one molecule, which constitutes oxygen in the free state. This partial satisfying of the polarities by the union of two or more polarities into one molecule, constitutes the difference between the chemical activity of free and nascent elements.

Dr. Siemens has recently propounded a theory of the sun's heat, based upon the fact that the radiant heat and light have the power of dissociating the elements of water when they pass through its vapour in a highly rarefied state, and that the dissociated elements, when drawn down to the denser atmosphere of the sun, re-unite, giving out again the heat which had effected their separation. A reasonable objection has been raised to this theory, that is, that the heat which we estimate as the sun's loss is only that which escapes this trap to catch the sunbeams. But, however much heat may escape from the sun into space, it does not seem necessary that we should establish new laws for the conservancy of the solar system. If force radiates from the sun as heat and light against space, diminishing in proportion to the square of the distance from the sun, the same force reflected back from space as from a hollow spherical reflector would come back directly to the sun undiminished. But as space is not a reflector of heat and light, may we not speculate on these overflowing vibrations causing a mechanical reaction, the backward flow of some other force, say gravity? Is it not a more reasonable speculation that gravity should be convertible with the other forces and keep up the cycle of natural change, than that all the stars are pouring forth their heat and light into infinite space, receiving nothing in return, and so to go on till, in the lapse of countless ages, all comes to utter darkness and inconceivable cold? Our common experience is that a hot body tends to become cold, but he would be a bold physicist who would asssert that the universe as a whole had the same tendency. On the one hand we have no experience of the universe as a whole, and on the other we have experience of numberless cases where, in ignorance, it was supposed that force was lost, but in which further knowledge showed that it was not lost but converted into another form. We are as yet unacquainted with any means by which gravity may be converted directly into any force except mechanical motion, but the conversion of the forces is a subject so new, in comparison with the length of time during which the forces have been studied as separate and unconvertible agents, that it would be unreasonable to assume that because we have not yet seen the means of converting the force of gravity into heat or light except through the intervention of mechanical motion, we are not likely to do so. We have converted heat into electricity and electricity into heat—magnetism into electricity and electricity into magnetism, and so on in many other cases, which have been among the most interesting achievements of science during the last half century.

If the action of gravity be reduced to that of radiant force acting in all directions, the apparent attraction being the subtraction of impacts on that side of a body to which the action of gravity tends to move it, then all bodies must have a diadynamous property at least as perfect as the diaphanous and diathermanous property of air. The proportion of impact force a body transmits compared to that which it intercepts, gives the difference in weight of a second body weighed above and below the first. The proportion of impact force which a body intercepts, compared to that which it transmits, gives its mass, and the excess of impacts it receives in one direction over the other multiplied into its mass gives its weight. One very marked difference between gravity and other forces is that the relationships which an element bears to all the other forms of force are changed by chemical combination, while its relation to gravity remains constant. When iron combines with chlorine, its relations to heat, light, electricity, and magnetism are essentially changed, but its weight remains the same. On this exceptional constancy in the relationship between gravity and matter in its different states of combination depends the possibility of exactness in chemical science.

It is with pleasure, not unmingled with reverence, that we feel our views of force and matter extending and promising that we shall see the unity and harmony of all nature. It must be regarded as a narrow view, a small-world prejudice, to look upon our solar system as a centre, radiating force upon all creation, giving out force, in the form of heat and light, in quantity inconceivably greater than it receives. Our common experience is that there is a general tendency in all nature to the restoration of physical equilibrium, the bent spring tends to relax, the suspended weight to come to the ground, the hot or cold body to come to the temperature of the bodies surrounding it, and we have naturally assumed, though with too little reason, that a state of rest, of inactivity, of monotony, and of death, is the natural goal to which all things tend.

We do not *know* that our system is become colder, and the sun less luminous; and if we did, we still do not know that we are not accumulating some other force, at present beyond our discovery.

On the other hand, we are daily becoming more convinced—more *certain* that force is not destroyed.

We are learning to count the atoms, to weigh the imponderable, and to measure that which has neither size nor shape; and we may with hopeful anticipation look for the laws which govern the chemical action of light and heat, and bring gravity into close relationship with the other forces of nature.

Mr. John Pattinson—I have much pleasure in moving that our cordial thanks be given to Mr. Proctor for his very interesting and philosophical address. He has dealt with the most mysterious problems of physics, and has given us ample scope for reflection, and our younger members ample material for research.

Mr. N. H. Martin—I have much pleasure in seconding the proposal. I have heard the address with great interest, and I look forward with great interest to its perusal. I think that one advantage which will accrue from amalgamation with the Society of Chemical Industry will be that addresses like Mr. Proctor's will be seen by a greatly increased circle of readers.

Mr. Proctor then thanked the meeting, and the proceedings closed.

NOTICES OF BOOKS.

Elementary Lessons in Electricity and Magnetism. By Silvanus P. Thompson, D.Sc., F.R.A.S. London: Macmillan and Co.

This treatise is avowedly written for beginners, but not with reference to any prospective examination—the exclusive goal which so many of our elementary text-books have in view. A series of exercises and problems is, indeed, appended, not, however, that the student may "get up" the answers, but with the perfectly legitimate object that he may test his own power of understanding what he has read.

Dr. Thompson,—most judiciously in our opinion—does not pre-suppose advanced mathematical attainments on the part of his readers. A knowledge of algebra as far as simple equations and of the first book of Euclid is all that he demands.

The author's method is eminently satisfactory. In the first chapters of his work he sets forth the principal experimental facts of the three great branches of his subject, to-wit, frictional electricity, current electricity, and magnetism. The correlation and explanation of these facts is reserved until afterwards. In so doing he is in harmony with the practice of all truly rational science teachers of the present day who ascend from phenomena to laws, thus making the course of instruction harmonise with that of discovery. This is a capital step in advance as compared with the old method of laying down at the outset certain abstract propositions, and endeavouring afterwards to prove or to illustrate them by observation and experiment. We suspect that no little of the "dry" and repulsive character popularly ascribed to science is due to this old method of teaching.

Prof. Thompson adopts the theory that electricity is unitary and not dualistic in its character, and also that it is neither matter nor energy, though, like both matter and energy, it can neither be created nor destroyed. A doctrine underlying his teachings is that of the conservation of electricity. He shows that "all our electrical machines and batteries are merely instruments for altering the distribution of electricity by moving some of it from one place to another, or for causing electricity when accumulated or heaped together in one place to do work in returning to its former level distribution."

The author in the body of his work treats in succession of frictional electricity, of magnetism, and of current electricity, proceeding in each case from the elementary phenomena. In the second part of the treatise he enters upon theoretical considerations, discussing electro-statics, electro-magnetics, the measurement of currents, the production of heat, light, and work from electric currents, the relations between light and electricity, induction currents, and electro-chemistry. A final chapter is devoted to an account of electric telegraphs and telephones. In all cases the author's descriptions and explanations are clear, and as full as the moderate compass of the work will permit. We note in one of the earliest paragraphs that whilst some physicists speak of "two electricities," and of one or of two electric fluids, Dr. Thompson more judiciously speaks of "two kinds of electrification" or of "two electric states." The notion of an electric fluid he emphatically rejects. The confusions and misconceptions which have sprung from this unhappy term, or rather from the underlying idea, are serious, and it is much to be regretted that it should still figure in popular writings and discourses.

From a paragraph on muscular contraction (p. 185) it appears that the biologist, Swammerdam, anticipated Galvani by a century! "In 1678 he showed to the Grand Duke of Tuscany that when a portion of muscle of a frog's leg hanging by a thread of nerve bound with silver wire was held over a copper support, so that both nerve and wire touched the copper, the muscle immediately contracted." So that we might, perhaps, speak of "Swammerdamism" in place of "Galvanism." It is, however, improbable that Galvani was aware of this experiment; nor does Swammerdam seem to have given any further attention to the subject.

Among the chief additions in the present edition of Prof. Thompson's work as compared with the two former, we notice an account of the secondary batteries of Planté and others, of Edison's latest improvements in incandescence lamps, and of Nordenskiold's observations on the aurora. The question arises, however, whether the causes of this phenomenon are not of cosmic rather than of terrestrial origin. The new units of measurement adopted by the Paris Congress have also been introduced.

Among the works of their class these "Elementary Lessons" must take a very high rank, and may be recommended to all students who wish to acquire a clear knowledge of electricity and magnetism.

CORRESPONDENCE.

ON THE DISCOVERY OF THE PERIODIC LAW.

To the Editor of the Chemical News.

Sir,—It has been lately announced that the Royal Society have awarded "the Davy Medal (in duplicate) to D. Mendelejeff and Lothar Meyer, for their discovery of the periodic relations of the atomic weights."

Having been the first to publish the existence of the periodic law, in the pages of the Chemical News, more than eighteen years ago, I feel, under these circumstances, compelled to assert my priority in this matter.

That both of the above-named eminent chemists have done a good deal to develop the periodic law is admitted, but this admission by no means assumes that either of them was the first discoverer of the law in question. As a matter of simple justice, and in the interest of all true workers in science, both theoretical and practical, it is right that the originator of any proposal or discovery should have the credit of his labour.

I will now give the dates of my several papers on the subject, published by me long before M. Mendelejeff had printed anything upon the question.

In a paper (Chemical News, vol. x., p. 59), July 30, 1864, I gave a list of all the then known elements in the order of atomic weight, which was the first ever published. Another table was appended, giving a horizontal arrangement of the more important elements, also in order of atomic weight, with blanks corresponding to some of the missing members of various groups. Thus, in the trivalent group, commencing with boron, there was a blank next below zinc, since filled by gallium, and another blank immediately below cadmium, since filled by indium. It was also pointed out that in the group containing carbon, silicon, titanium, and tin, there was an element wanting having an atomic weight of 73, being, in fact, the same missing element which M. Mendelejeff has recently predicted under the name of eka-silicium.

In an appendix to this paper (Chemical News, vol. x., p. 94), August 20, 1864, I announced the existence of a simple relation or law among the elements when arranged in the natural order of their atomic weights, to the effect that the eighth element, starting from a given one, was a sort of repetition of the first, or that elements belonging to the same group stood to each other in a relation similar to that between the extremes of one or more octaves in music. This was accompanied by a horizontal grouping arrangement.

In the Chemical News, vol. xii., pp. 83 and 94 (Aug. 18 and 25, 1865), I published a full horizontal arrangement of the elements in order of atomic weight, and proposed to designate the simple relation existing between

them by the provisional term "law of octaves." This law has since been called by M. Mendelejeff the "periodic law."

On March 1, 1866, I read a paper on this periodic law before the Chemical Society, and a notice of this appeared in the CHEMICAL NEWS, vol. xiii., p. 113, and also in many other journals. In the CHEMICAL NEWS, vol. xiii., p. 130 (March 16, 1866), I wrote as follows:—"I have endeavoured to describe relations actually subsisting among the atomic weights of the elements at present known, but am far from thinking that the discovery of new elements (or the revision of the atomic weights of those already known) will upset for any length of time the existence of a simple relation among the elements when arranged in the order of their atomic weights.

"The fact that such a simple relation exists now affords a strong presumptive proof that it will always continue to exist, even should hundreds of new elements be discovered. For, although the difference in the numbers of analogous elements might, in that case, be altered from 7, or a multiple of 7, to 8, 9, 10, 20, or any conceivable figure, the existence of a simple relation among the numbers of analogous elements would be none the less evident."

Years afterwards the brilliant researches of Roscoe showed that the atomic weight of vanadium was 51·2, instead of 137. This reduction in the atomic weight of vanadium at once placed that metal in the same line as the phosphorus group, thereby confirming the periodic law. It may also be stated that in the CHEMICAL NEWS, vol. x., p. 95, I predicted that the atomic weight of indium might "prove to be identical, or nearly so, with those of zinc or cadmium."

To sum up, I claim to have been the first to publish a list of the elements in the order of their atomic weight, and also the first to describe the periodic law, showing the existence of a simple relation between them when so arranged.

I have applied this periodic law to the following among other subjects:—

1. Prediction of the atomic weight of missing elements, such as the missing elements of the carbon group = 73, since termed eka-silicium by M. Mendelejeff.

2. Predicting the atomic weight of an element whose atomic weight was then unknown, viz., that of indium.

3. Selection of Cannizzarro's atomic weights, instead of those of Gerhardt, or the old system, which do not show a periodic law (CHEMICAL NEWS, vol. xiii., p. 113).

4. Predicting that the revision of atomic weights, or the discovery of new elements, would not upset the harmony of the law—since illustrated by the case of vanadium.

5. Explaining the existence of numerical relations between the atomic weights (CHEMICAL NEWS, vol. xiii., p. 130).

6. Where two atomic weights were assigned to the same element, selecting that most in accordance with the periodic law: for instance, taking the atomic weight of beryllium as 9 4 instead of 14.

7. Grouping certain elements so as to conform to the periodic law instead of adopting the ordinary groups. Thus, mercury was placed with the magnesium group, thallium with the aluminium group, and lead with the carbon group (CHEMICAL NEWS, xiii., p. 113). Tellurium, on the other hand, I have always placed above iodine, from a conviction that its atomic weight may ultimately prove to be less than that of iodine.

8. Relation of the periodic law to physical properties—showing that similar terms from different groups, such as oxygen and nitrogen, or sulphur and phosphorus, frequently bear more physical resemblance to each other than they do to the remaining members of the same chemical group (CHEMICAL NEWS, vol. x., p. 60).

It is not denied that I was the first to publish a list of elements in the natural order of their atomic weights, and Wurtz has written, in reference to the periodic law, that "it is a circumstance worthy of remark that such varied and unexpected developments arise from the simple idea of arranging bodies according to the increasing value of their atomic weights. This simple idea was a most important one." ("The Atomic Theory," by A. Wurtz; Translation, p. 170; London, 1880.)

As evidence of the opinion of various writers on the subject the following may be quoted:—

M. Mendelejeff (CHEMICAL NEWS, vol. xliii., p. 15):—"It is possible that Newlands has prior to me enunciated something similar to the periodic law, but even this cannot be said of H. L. Meyer."

Dr. Odling, Lecture on Gallium, before the British Association, in 1877:—"Mr. Newlands was the first chemist to arrange the elements in such a seriation that new ones might be predicted to exist where certains gaps are observed in the seriation of atomic weights."—(*Pharmaceutical Journal*, August 25, 1877, p. 144.)

"Fownes's Chemistry," vol. i., 12th ed., 1877, p. 265:—"This relation of the elementary bodies, which is called the 'periodic law,' was first pointed out by Newlands in 1864, and afterwards developed by Odling and Mendelejeff."

Miller's "Elements of Chemistry," Part II., 6th ed., 1878, p. 974:—"Periodic law of Newlands and Mendelejeff." "This periodic law was first pointed out by Newlands in 1864."

"Roscoe and Schorlemmer's "Chemistry," vol. ii., Part II., 1879, p. 506:—"The first attempt to point out that the properties of the elements varied periodically was made by Newlands in 1863." "The law of periodicity was afterwards further developed by Meyer and Mendelejeff."

"Watts's Dictionary," vol. viii., 1879, 3rd Supplement, Part I., p. 729:—"The idea of a periodic relation between the atomic weights of the elementary bodies and their quantivalence and other properties, developed by Mendelejeff in the manner already described (2nd Suppl., 462), was first suggested by J. R. Newlands in 1864."

Dr. Tilden, "Chemical Philosophy," 2nd ed., 1880, p. 246:—"In the year 1866 a very curious observation was made by Mr. Newlands to the effect that when the elements are arranged in a continuous series in the order of their atomic weights, commencing with hydrogen, there is at equal intervals in the series a recurrence of the same or similar general characters, both physical and chemical. This periodic revival of characteristics occurs, with a few exceptions, at about every eighth member of the series, as will presently be shown. This discovery has been elaborately studied by Mendelejeff and Lothar Meyer, and that which has long been vaguely recognised is now fully established, namely, that the properties of the elements stand in a definite relation to their atomic weights."

Sir John Lubbock's Address to the British Association, in 1881 (CHEMICAL NEWS, vol. xliv., p. 120):—"A periodicity in the atomic weights of elements belonging to the same class had been pointed out by Newlands about four years before the publication of Mendelejeff's memoir."—I am, &c.,

JOHN A. R. NEWLANDS, F.I.C., F.C.S.

Laboratory, 9, Mincing Lane, London, E.C.
December 11, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 20, November 13, 1882.

Results of Experiments made on the Electric Candles at the Exhibition of Electricity.—MM. Allard, F. Le Blanc, Joubert, Potier, and H. Tresca.—The results of the observers are given in a tabular form.

Note on the Reproduction of the Iridium Osmides.—H. Debray.—When iridium is heated with iron pyrites we obtain a regulus which on treatment with dilute hydrochloric acid leaves a deposit of crystalline iridium mixed with a black, light, amorphous sulphide, which dissolves very readily in nitric acid. It is therefore easy to separate the iridium from the medium in which it crystallises. It is first converted into a sulphide, which is decomposed at high temperatures, when it takes the crystalline form. This iridium is not absolutely pure; it contains from 1 to 2 per cent of iron, but it crystallises in regular octahedra. It is the same with osmium. This metal, fused with pyrites and a little borax at a high temperature, gives likewise a regulus, from which crystalline osmium can be extracted with its characteristic blue colour, and a black sulphide. The osmium thus obtained does not retain appreciable traces of iron, and has all the characters of the metal, as formerly obtained by the author and H. Sainte-Claire Deville by the action of hydrochloric acid upon the alloy of osmium with tin or zinc. The author has examined the action of pyrites upon mixtures of osmium and iridium in different proportions. He has obtained on treating the regulus successively with hydrochloric and nitric acid a homogeneous crystalline residue composed of regular octahedra with hexagonal plates, which recal certain natural osmides. Osmium and iridium can crystallise together in all proportions without any alteration of form, and are, therefore, isomorphous.

Note on the Telluric Rays, and the Spectrum of Watery Vapour.—J. Janssen.—The author refers to M. Cornu's memoir in the previous number of the *Comptes Rendus*. He criticises the historical part of M. Cornu's paper, and describes his own method for estimating the variations in the hygrometric state of the atmosphere.

Currents produced by Nitrates in Igneous Fusion on Contact with Charcoal heated to Redness.—M. Brard.—The author's chief results are: If into a capsule containing a bath of a nitrate in fusion, there is plunged a piece of carbon heated to redness, we obtain an energetic current, which proceeds from the bath to the carbon in the outer circuit. The nitrates in fusion become very fluid, and acquire the property of moistening heated bodies with which they are in contact to some height above their surface. To obtain a current it is not necessary to plunge the carbon into the bath of nitrate. Nitrates kept in a state of fusion possess great permanence. These salts, which melt at 200°, are not decomposed until about 1000° or 1200°. Up to that point they do not attack the metal crucible, &c., containing them, and even prevent, or at least retard, its oxidation by the fire.

Chemical Studies on the Sugar-Beet.—Hippolyte Leplay.—Continued from the last two numbers.

Exactitude of Determinations made with the Mercurial Thermometer.—J. M. Crafts.—The author advises that thermometers which are destined for laboratory experiments should before graduation be heated for a week or ten days in boiling mercury. This is the only method for obtaining instruments which keep the value of the degree fixed during graduation, and the errors in thermometers which have not undergone this treatment may reach 4° in 300°.

Conclusions from the Hydro-dynamic Experiments in Imitation of the Phenomena of Electricity and Magnetism: Reply to a Memoir by M. Ledieu.—C. Décharme.—The author by his researches has shown the analogy existing between the hydro-dynamic and the electric flux, whence it results that the thermic and the electric flux are assimilable to the liquid flux. The wave-theory, which already explains all the phenomena of light, heat, and of sound, seems to be the secret of Nature.

Electric Deformations of Quartz.—MM. Jacques and Pierre Curie.—See p. 260.

Electrisation of the Air.—M. Mascart.—The author follows up a suggestion of Sir W. Thomson's on continuous observations of the electrisation of the lower strata of the air by determining the potential in a limited volume of gas taken from the ambient air, and withdrawn from the action of foreign electric masses.

Atmospheric Nitrification.—A. Muntz and E. Aubin.—In the Pyrenees the violent electric phenomena which appear as thunderstorms do not exceed the altitude of 3000 metres. Consequently the formation of nitrates under electric influence is below this limit. In rain, snow, and fog on the summit of the Pic du Midi, the authors find that nitrates are substantially absent. Hence the vegetation of high mountains and the soil which it forms must obtain their nitrogenous matters merely from the ammonia of the atmosphere.

Decomposition of Phosphates by Potassium Sulphate at High Temperatures.—H. Grandeau.—Aluminium phosphate heated to a very high temperature with an excess of alkaline sulphate gives an alkaline phosphate and crystalline alumina. This reaction, which is due to M. Debray, has been proposed by M. Derome as a means of determining phosphoric acid. The author examines in what conditions are alumina and phosphoric acid separated from each other in presence of potassium sulphate? For this purpose he heated a mixture of aluminium phosphate and potassium sulphate in a platinum crucible for several hours. He finds that the decomposition of the aluminium phosphate at a very elevated temperature gives rise, not merely to crystalline alumina, but to a double aluminium and potassium phosphate, crystalline and of definite composition. The more the temperature is raised, the more considerable the proportion of alumina becomes. But it is very difficult when operating upon weights at all considerable, to effect, even with the most energetic sources of heat, the complete decomposition of the double phosphate. In most cases we obtain, not the whole of the alumina in the crystalline state, but a mixture of the two products. The experiment has been repeated with intermediate oxides little known, such as those of glucinium, cerium, didymium. The result of the operation has been the same as for alumina. The author has thus obtained a crystalline glucinium and potassium double phosphate. Among the protoxides there are two distinct classes; some, such as lime and magnesia, never yield the oxide if their phosphates are treated with an alkaline sulphate. With others, such as nickel and cobalt, we observe the same phenomena as with aluminium. With other phosphates the case is again different. With chromium and uranium phosphates the final products are potassium chromate and uranate.

Solidification of Various Mixtures of Naphthaline and Stearic Acid.—H. Courtonne.—The author gives his results in a tabular form.

Œno-cyanine.—E. J. Maumené.—Œno-cyanine is originally colourless, and obtains its blue-black colour by oxidation and possibly by hydratation.

Cause of the Disengagement of Oxygen from Hydrogen Peroxide by means of Fibrine: Influence of Hydrocyanic Acid in Checking the Activity of Fibrine.—A. Béchamp.—The author shows the changes which fibrine undergoes on deoxidising hydrogen peroxide; it loses this reducing power; it no longer liquefies starch paste, and it no longer supports bacteria. It is not in virtue of a physiological process that hydrocyanic acid suppresses the action of fibrine upon oxygenated water.

Justus Liebig's Annalen der Chemie,
Band 215, Heft 2.

Imides of Bibasic Acids.—Dr. Max Landsberg.—The author examines phthalimide and succinimide in order to ascertain whether in these imides an atom of hydrogen can be substituted not merely by mercury and silver, but by metals of the most varied kinds, and if it is possible by starting from these imides to obtain their

ethyl-derivatives, which yield ethyl-amine by taking up water.

Communications from the Chemical Laboratory at Greifswald.—These consist of a memoir by Dr. P. Rodatz on the structure of certain azo-benzol-disulpho-acids; one by the same author on some bromised azo-benzol-disulpho-acids, and a memoir by Dr. H. Wilsing on the sulpho-acids of oxy-azo-benzol.

Mono-brom-pseudo-cumolic Acid and Dibrom-mesitylenic Acid.—H. Süssenguth.—The author describes the preparation of mono-brom-pseudo-cumol and of mono-brom-pseudo-cumolic acid and its salts; the preparation of brom-mesitylenic acid from brom-mesitylene, of dibrom-mesitylene from the oil of coal-tar, and of dibrom-mesitylenic acid.

Cosmos Les Mondes.
No. 9, October 28, 1882.

Detection of Spurious Butter.—M. Dony.—Artificial butter, if heated in a capsule or test-tube to from 150° to 160°, yields little froth, but undergoes a singular kind of ebullition accompanied by violent bumping, which tends to project a part of the sample out of the vessel. The fatty portion of the sample retains its natural colour, and the curdy matter turns brown, and is separated out in the form of clots which adhere to the sides of the vessel. Natural genuine butter, if treated in the same manner, behaves quite differently; it froths abundantly, and the bumping is much less violent. A good part of the brown colouring-matter remains suspended in the butter, so that the total mass preserves a characteristic and uniform brown colour.

Curious Explosions.—M. Pfaundler.—A sealed glass tube containing liquid carbonic acid had been immersed to the depth of some c.c. into a bath of carbonic acid and ether at the temperature of −100° in order to produce the crystallisation of the carbonic acid. Some fine crystals were formed in the submerged part of the tube, whilst a stratum of the liquid acid remained above. The tube was then raised out of the bath by its upper extremity, and in a few minutes there ensued a violent explosion. The second case relates to a large zinc gas-holder, used exclusively for containing oxygen. It had not been in use for six months, but a little gas had been allowed to remain within. When this gas as it issued was tried with a match an explosion took place which ruptured the apparatus. It is probable that the water had gradually absorbed acid vapours from the atmosphere of the laboratory, and had attacked the zinc, disengaging hydrogen.

Detection of Phenol in Urine.—The presence of phenol is commonly shown either by precipitating with bromine water so as to obtain tribromo-phenol, or by producing erythrophenic acid by means of sodium hypochlorite in presence of ammonia or of aniline. MM. T. and D. Tommasi use as acid a mixture of equal parts of distilled water and of pure hydrochloric acid, adding to every 100 c.c. of the mixture 20 centigrms. of potassium chlorate. They stir the urine with a rod of pine wood, which they then plunge for a very short time into the acid liquid. The rod is then exposed to the rays of the sun, and if phenol was present the characteristic blue colour appears in five minutes.

No. 10, November 4, 1882.

A new chemical journal has recently appeared at Leyden entitled "*Recueil des Travaux Chimique des Pays-Bas.*" It will be conducted by MM. Van Dorp, Franchimont, Hooge-Werff, Mulder, and Oudemans.

No. 11, November 11, 1882.

A Substitute for the Sand-bath.—M. Kaistalba.—The author proposes pounded graphite as a substitute for sand.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., October, 1882.

This issue contains no chemical matter.

MEETINGS FOR THE WEEK.

Monday, 18th.—Medical, 8.30.
—— London Institution, 5.
—— Society of Arts, 8. "Dynamo-electric Machinery," by Prof. Silvanus P. Thompson, D.Sc.
Tuesday, 19th.—Institution of Civil Engineers, 8. (Anniversary.)
—— Pathological, 8.30.
Wednesday, 20th.—Society of Arts, 8. "The Utilisation of Waste. A Quarter of a Century's Progress," by Peter Lund Simmonds.
—— Meteorological, 7.
—— Geological, 8.
Thursday, 21st.—Chemical, 8. "On the Condensation-Products of Œnanthol," Part II., by W. H. Perkin, Junr., Ph.D. "The Behaviour of the Nitrogen of Coal during Destructive Distillation: with Observations on the Estimation of Nitrogen in Coal," by W. Foster. "On the Absorption of Weak Reagents by Cotton, Silk, and Wool," by E. J. Mills, D.Sc., F.R.S., and Jokichi Takamine. "Note on Nitro-benzyl-cyanide and some Derivatives with Diazo-bodies.
—— Royal, 4.30.
—— London Institution, 7.
Friday, 22nd.—Quekett Club, 8.

TO CORRESPONDENTS.

L. Rowland Hill.—Many leading physicists adopt this view, but it is by no means universally admitted.

EDITED BY HENRY WATTS, B.A., F.R.S.,
Editor of the Journal of the Chemical Society.

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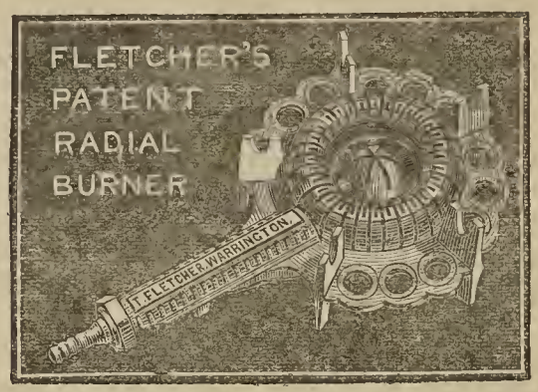

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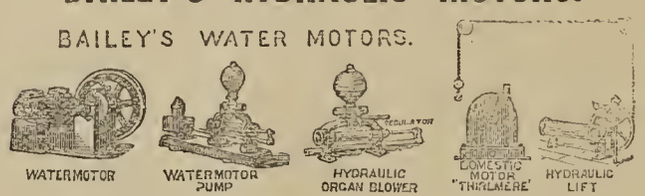

Silver Medal, Manchester, 1879; *Blackburn*, 1881.

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THE CHEMICAL NEWS.

Vol. XLVI. No. 1204.

RUPERT'S DROPS.

By I. TAYLOR, B.A. (Oxon.)
Science Master at Christ College, Brecon.

It is stated in Chemical Text-books (for example, Roscoe and Schorlemmer's "Chemistry," vol, ii., Part I.; Miller's "Elements of Chemistry," Part II.) that Rupert's drops may be obtained by allowing molten glass to fall into cold water: I find that it is almost impossible to manufacture the drops in such a manner. I have used cylinders of different lengths, with water of various degrees of temperature, with the same result, the glass almost invariably breaking up into a number of small fragments directly it strikes the bottom of the cylinder. The drops may, however, be very easily obtained by using a saturated solution of ammonium chloride—freshly prepared with cold water (6° to 8° C.)—contained in a cylinder about 18 ins. long, the increased specific gravity and cold ensuring the almost complete cooling of the glass before it reaches the bottom of the cylinder.

PYROLOGICAL NOTES.

By Lieut.-Colonel W. A. ROSS, late R.A.

(Continued from p. 273)

VII. Boric Acid and Aluminium Plate. Two Analyses of *Smaltite*.

It is very much to be regretted that Prof. H. B. Cornwall should have allowed himself to make use of the following vaticanatic remark in the preface to his "Manual of Blowpipe Analysis," just published at New York:—"No really useful Manual of Blowpipe Analysis can be produced without the aid of Plattner's well known work." As my little "Manual," published in 1880, is the only work to which this observation *ex cathedrâ* of the "John C. Green School of Science" can possibly refer, I ask your permission to take up the gauntlet thus thrown down, and to attempt to show in your pages, by means of Prof. Cornwall's own book, that it is not only possible to produce something "really useful" to the public in the way of blowpipe analysis, without making it a mere *réchauffé* of Plattner's "Probirkunst" and Von Kobell's "Bestimmung der Mineralien," but that, on the other hand, those modern pyrological works which persistently ignore all advancement or admitted improvement in the mechanical or chemical portions of this science unless they have proceeded from Freiberg, or Munich, or New York, are simply neglecting their own interests not less than those of the public.

Cornwall's qualitative analysis of the mineral *Smaltite* $(Co,Ni,Fe)As_2$, page 105:—(1) "To be fused in a shallow cavity on charcoal with a moderate R.F. until the arsenic fumes cease. (2) A small piece of borax glass is added, and the O.F. directed for a short (?) time on the borax. Any iron arsenide present (sometimes about 18 per cent) will be first oxidised, and, if the blast is stopped as soon as the metallic button of arsenides appears bright, while still melted, the iron can be detected in some of the separated glass by oxidising this, with a little more borax if very dark, on platinum wire in O.F. (3) The borax bead will then show the yellow colour indicative of iron, or the green colour due to a mixture of some blue from cobalt with the iron in the borax, if the operation had not been stopped at the right moment. (4) When the button of arsenides is again oxidised with fresh borax the glass will be coloured blue, since the cobalt arsenide will next be oxidised and dissolved. (5) After the cobalt (sometimes about 20 per cent, 0·05 per cent giving a strong blue colour to a borax bead) is removed, there will remain, if nickel and copper are present, a button of the arsenides, which will no longer remain bright while melted, as it did in the presence of the cobalt arsenide, but will begin to show a film of nickel arsenate. (6) The blast should be stopped now, and the button again oxidised beside fresh borax, to which it will at first impart the reddish brown nickel colour. (7) Any copper present (about 0·29) can be found in the remaining button by means of S.Ph. (microcosmic salt) on wire in O.F., shaking off the bead into a porcelain dish, and treating it in a moderately deep cavity on charcoal beside a bit of tin, half as large, with R.F., just long enough to fuse the two together. (8) The tin will, of course, not dissolve in the S Ph., but only adhere to it. The bead *when cold*, will be distinctly red and opaque, or only slightly reddish, according to the amount of copper present. The red colour is due to the formation of cuprous oxide (suboxide, Cu_2O). (9) The R.F. must not deposit soot on the bead."

The student must remember that the whole of this long and complicated series of processes, which if there be much cobalt, iron, and nickel, and, as is always the case, a mere trace of copper present, will occupy some hours, is simply qualitative, and that he is expected to go through these prolonged and fatiguing operations with a mouth blowpipe, for the mere purpose of detecting the above-mentioned three metals and trace of copper in this ore; and (by way of encouragement) Prof. Cornwall adds, he "will not find it easy to follow accurately the above changes in the appearance of the melted button of arsenides, especially if it is small."

Qualitative Analysis of Smaltite by means of Al. Plate and Boric Acid.

(1) Paste on Al. plate O.P., a copious white sublimate, volatilising in H.P. with garlic smell (large proportion of arsenic): with charcoal slip, O.P. no further sublimate (no other volatile metal).

(2) The cake which forms, turned over occasionally, is roasted by P.P. on the bare plate until all the arsenic is sublimed,* and the powder applied to a boric acid bead O.P.; instantaneous, blue-green pyrochrome, with one or two blue-black opaque balls, showing a coppery suffusion after H.P. (trace of copper); black opaque balls, —numerous in proportion to the quantity present—violet after H.P., which, on addition of soda O.P., afford a pink bead; blue hot (cobalt); brown-black opaque balls, with rust-like matter round them—numerous in proportion to the quantity present—(iron); green fragments, showing a white metallic lustre after H.P.—numerous in proportion to the quantity present—(nickel).

If Prof. Cornwall doubts the fact of these reactions, not having tried them (which is the easiest and most usual form of objection to my processes), I can refer him to Herr Pufahl, the Chemical Assistant of Herr Professor Bruno Kerl, of the Imperia lMining Academy, Berlin, who *has* (very kindly) tried them, and published his experience in the "Berg und Hüttenmannische Zeitung," vol. xli., p. 101, No. 11, March 17, 1882.

The Antiseptic Properties of Carbonic Acid.—H. Kolbe.—The author concludes from his many and extensive experiments that carbonic acid is an excellent agent for preventing beef from putrefying and preserving its flavour for some weeks. Mutton behaves differently, and after remaining for eight days only in carbonic acid it gives off a putrid odour. Veal is not protected nearly so well as beef.—*Journ. für Praktische Chemie.*

* There is no other known method of roasting by which *all* the arsenic can be so separated.

ON THE

PREPARATION OF THE ALKALINE POTASSIUM PERMANGANATE SOLUTION USED FOR WATER ANALYSIS.

By JOSEPH STAPLETON.

DR. TIDY appears to have been the first chemist to draw attention to the difficulty of preparing this well-known reagent free from ammonia.* The subject has recently been revived in the CHEMICAL NEWS by Mr. Reuben Haines (CHEMICAL NEWS, vol. xlvi., p. 229). The difficulty is undoubtedly real, and any attempts at its reduction will probably be of interest to chemists using the "ammonia process" of water analysis.

Mr. Haines describes briefly but sufficiently the devices tried by Dr. Tidy for preparing the solution, and he gives his own method of operating. As regards Mr. Haines's method, I am inclined to think from my experience that with some samples of caustic potash he would have great difficulty in obtaining the solution anything like free from ammonia in a reasonable time. I am decidedly of opinion, from a lengthy course of experimenting, that the potash is the chief source of the ammonia evolved during the preparation of the solution. Nitrogenous matter in some form or other appears to be present in most commercial samples of potash, and seemingly this nitrogenous matter is not entirely removed by fusing the potash at a dull red heat. This fact was known to myself and others previous to Dr. Tidy placing it on record in his valuable paper (*loc. cit.*) before the Chemical Society.

A device which has proved very serviceable in my hands for getting rid of a great part of this nitrogenous matter is to make the potash solution with rather hard water, containing dissolved calcium carbonate (New River Company's water for example). The precipitate of calcium carbonate thus formed by neutralisation of the carbon dioxide in the water apparently carries down with it a large portion of the nitrogenous matter. The precipitate is allowed to subside as completely as possible, the subsidence being generally completed in twenty-four hours, though more time may be allowed with advantage. If, after standing for twenty-four hours small flakes of suspended matter are noticeable in the solution, filtration through asbestos may be employed, but this is rarely necessary, the solution being generally bright and clear after standing for the length of time stated, The potassium permanganate is dissolved in a separate portion of hot distilled water, and mixed when cold with the potash solution; the mixed solutions are then made up to about half the proper bulk with distilled water.

The alkaline permanganate solution thus prepared will yield a comparatively large quantity of ammonia by further purification. The best method of effecting this appears to be by distillation, but the usual method of distillation is attended with serious inconveniences in the fracture of the retort and frequent loss of the entire contents. I have known three or four retorts to be broken in succession just as distillation commenced. This troublesome feature may be very satisfactorily overcome by passing steam at atmospheric pressure through the liquid, the steam being led very nearly to the bottom of the retort. When the steam is passing through the solution tumultuously, heat may be applied to the retort by a rose Bunsen, otherwise the distillate comes over very slowly. It is even advisable to heat the solution on a water-bath before placing it in the retort; for subsequent augmentation of the volume of the solution from condensation of the steam is thereby greatly lessened. The "rousing" action of the steam is much assisted by having pieces of ignited pumice stone in the retort.

The distillate is nesslerised after a few c.c. have collected, and this is repeated until only 0·005 m.grm. of ammonia is obtained from 1 litre of the alkaline permanganate under operation. When this point is reached the solution may be considered practically free from ammonia. The distillation rarely takes longer than one hour.

It is of importance to use for generating the steam, water that does not give off ammonia continuously whilst boiling, otherwise of course the results of the process are misleading.

The retort ought not to be more than one-third full of the solution, as the tumultuous boiling is otherwise liable to jerk portions of the liquid into the neck of the retort, and from thence it gets into the distillate, and thus nesslerising is rendered impossible. If possible it is advisable to slant the neck of the retort upwards with a view to preventing this.

Another precaution I have found from experience to be desirable is to support the retort upon a tripod stand covered with wire gauze, from which it should not be removed at the conclusion of the operation, but the contents emptied by a syphon. By this means should a fracture of the retort have taken place while working, the loss of the contents is avoided.

Summarising briefly, the process consists in (1) the purification of the potash solution by a kind of "Clark's process," and (2) distillation of the mixed solutions of alkali and permanganate, aided by "direct steam."

The process has been in constant use for some two years, both in my own hands and by several other chemists to whom it has been communicated, and invariably with satisfactory results.

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* *Journ. Chem. Soc.*, 35, p. 62.

VOLUMETRIC DETERMINATION OF COPPER, IRON, AND ANTIMONY BY THE PROCESSES OF M. F. WEIL.

§ 1. *Determination of Copper.*

Theory of the Process.—The process depends on the following principles:—Hydrochloric acid in great excess is the most sensitive reagent for detecting the presence of copper. In presence of such an excess and at the boiling heat, the least trace of copper chloride communicates a very decided greenish yellow tint to the solution. The more free hydrochloric acid is present the more intense is the colouration.

Stannous chloride instantly converts cupric salts dissolved in an excess of hydrochloric acid into cuprous salts, which are soluble and absolutely colourless. The reaction takes place according to the formula—

$$2CuCl_2 + SnCl_2 = Cu_2Cl_2 + SnCl_4.$$

At the moment when by the addition of the stannous chloride, the greenish yellow of the hydrochloric solution has entirely disappeared, and the liquid becomes colourless, like distilled water, the reaction is complete.

The volume of solution of stannous chloride, titrated by means of a known quantity of pure copper, which has to be employed for the complete decolouration of the substance under analysis, indicates with the utmost exactness the quantity of copper contained in the sample.

When titrating at a boil the flask is filled constantly with hydrochloric vapours, which prevents the least re-oxidation, during the process, of the cuprous chloride formed.

Dissolve 5 grms. of the ore or cupriferous matter in question in hydrochloric or sulphuric acid, or in water. Introduce the solution into a graduated glass cylinder, and make up to 250 c.c.

For preparing the standard tin solution, dissolve 4·5 to 5 grms. tin crystals in about 100 grs. water and 30 grms. hydrochloric acid, and filter into a half-litre flask. Fill

up the half-litre with water acidified with about 40 per cent by volume of hydrochloric acid.

For standardising the tin solution introduce by means of a pipette 10 c.c. of the normal copper solution No. 1 (see below) into a small flat-bottomed flask of white glass, add 25 c.c. of hydrochloric acid, and heat to a boil by placing the flask upon a hot plate. The boiling solution is of an intense greenish yellow; the solution of tin to be standardised is run in with a burette graduated in tenths of a c.c. As soon as the liquid on stirring shows merely a feeble colouration, the tin chloride is added drop by drop, still stirring. When the addition of a drop completely decolourises the liquid (a similar flask of distilled water may be used for comparison), the quantity of tin solution required to decolourise 0·1 grm. of pure copper in hydrochloric solution is known.

The actual analysis is executed in the same manner, introducing 10 c.c. of the solution of the sample into the white glass flask, adding 25 c.c. of hydrochloric acid, and running in the standard tin solution drop by drop to the boiling solution till it is completely decolourised. After each series of determinations the tin solution must be re-standardised.

For ores or alloys which have to be dissolved in nitric acid or *aqua regia*, we dissolve 5 or 2 grms. in nitric acid or *aqua regia*, and evaporate to dryness or nearly so in a porcelain capsule. The residue is re-dissolved in hydrochloric acid, and the solution made up to 250 c.c. with water. The whole is well stirred. 10 c.c. of this solution are then mixed with 5 to 10 c.c. of hydrochloric acid, and evaporated to dryness in the porcelain capsule.

The absence of nitric acid may be ascertained by means of a slip of iodised starch paper. The hydrochloric vapours do not turn the paper blue except nitric acid or free chlorine is present. In that case the liquid is evaporated to dryness for a third time along with hydrochloric acid. The residue is dissolved in 25 c.c. of hydrochloric acid and titrated as above.

§ 2. *Determination of Iron.*

Hydrochloric acid gives solutions of ferric chloride a yellow colour, which stannous chloride decolourises, reducing the iron to the ferrous state. When there are 2½ volumes of free hydrochloric acid to 1 vol. of the ferric solution, the yellow colour is so well marked, and the decolouration by stannous chloride so definite, that no indicator is needed. The iron is titrated with the tin solution standardised with pure copper. The volume of tin chloride used indicates the quantity of iron in the sample but expressed by its equivalent in copper. We require merely to multiply the result by the coefficient 0·88328 to find the percentage of metallic iron. For executing the process weigh and dissolve 5 or 2 grms. of the sample. Introduce 10 c.c. of the solution (containing the iron in the state of ferric chloride, 250 c.c. of the solution containing 2 grms. of the sample) into a small porcelain capsule, and add 10 c.c. of the normal solution of copper = 0·04 grm. of pure copper of bottle No. 2. Evaporate the whole to the third or fourth of its bulk. Pour this concentrated solution into a white glass flask, and add 25 c.c. of hydrochloric acid which have served to rinse completely the porcelain capsule, and titrate with the tin solution to decolouration. Add further from 50 to 40 c.c. of hydrochloric acid, and if this addition produces a slight colouration add tin solution drop by drop till it entirely disappears. In calculating the result the number of c.c. of the tin solution answering to the 10 c.c. of copper added must be deducted.

For ores and substances containing more than 2 per cent of iron the addition of copper is needless. If the solution under analysis contains the iron wholly or partly in the ferrous state, we add to the 10 c.c. taken for the assay a little of an aqueous solution of potassium permanganate until a slight permanent red colour remains. mant then with hydrochloric acid until the vapours given off no longer give a blue colour to iodised starch paper.

§ 3. *Simultaneous Determination of Iron and Copper.*

Take 5 grms. of ore = 250 c.c. of solution. Suppose 10 c.c. of this solution have required 25 c.c. of standard tin. But 10 c.c. of normal copper solution = 15·8 c.c. tin solution, and 25 c.c. of tin solution at this strength represent 79·10 per cent of copper and of iron represented by its equivalent in copper.

For the titration of the iron alone introduce 10 c.c. of the solution to be analysed into a flask. Add 30 c.c. of water, 5 to 10 c.c. of hydrochloric acid, and 3 to 5 grms. of pure granulated zinc. Boil for about twenty minutes, and filter the solution. The filtrate contains all the iron in the ferrous state, whilst all the copper remains with the excess of zinc upon the filter. Add to the filtrate, mixed with the washing-water, solution of permanganate until a permanent rose colour appears. Concentrate to about 5 c.c., heating till the vapours no longer turn iodised starch paper blue, and titrate as already explained.

§ 4. *Determination of Antimony.*

First Process.—Stannous chloride instantly converts antimonic chloride into antimonious chloride. The solutions of both these chlorides are colourless. On adding to the solution of antimonic chloride a given volume of a solution of copper of known strength, and a large excess of free hydrochloric acid, the mixture takes a greenish yellow colour. The volume of tin solution (standardised with copper) which has to be used to decolourise the mixture, indicates the sum of copper and antimony. On deducting from this sum the quantity corresponding to the known quantity of copper added, the remainder is the volume of tin solution which has served for the reduction of the antimonic chloride. The quantity of copper corresponding to this volume, multiplied by 0·96214, gives the weight of metallic antimony in the sample.

Second Process.—This process is based upon the fact that antimonious chloride is not re-oxidised upon prolonged contact with the air, whilst the solutions of cuprous chloride are completely re-oxidised on exposure, and in some hours resume their original greenish yellow colour. A first titration with the tin solution indicates, consequently, the volume of tin chloride corresponding to the sum of copper and antimony. On letting the solution remain exposed to the air for nine hours it resumes its primitive colour, and on re-titrating the volume of tin solution employed indicates merely copper.

When making up the solutions of antimonic samples to 250 c.c. it is necessary to employ an aqueous solution of tartaric acid to prevent precipitation.

§ 5. *Simultaneous Determination of Antimony and Copper in the same Substance.*

The mode of operation may be inferred from the second method given for the determination of antimony.

Substances containing Antimony, Copper, and Iron.—Dissolve 2 or 5 grms. of the sample in concentrated nitric acid; evaporate to a small volume and filter. The filter made up with water to 250 c.c. now contains merely the iron and copper, and is treated as above directed. The residue on the filter contains all the antimony, and is dissolved in hydrochloric acid, and treated with permanganate. The concentrated solution containing all the antimony as antimonic chloride is titrated as above.

Preparation of the Normal Copper Liquids.—No. 1 and No. 2.—No. 1. Powder pure crystalline copper sulphate, dry it between white blotting papers; dissolve 19·6675 grms. in about 200 grms. water, and make up to half a litre.

No. 2. Operate in the same manner, but use only 7·867 copper sulphate.—*Revue des Mines.*

Second Anhydride of Mannite.—A. Fauconnier.—The author submits mannite to dry distillation in a vacuum. The portions collected at 160° to 190° under a pressure of 0·03 m. consist in part of the second mannitic anhydride, $C_6H_{10}O_4$.—*Comptes Rendus.*

THE REMOVAL OF FIXED GLASS STOPPERS.*

When the glass stopper of a bottle is ground fine enough to prevent leakage and is well put into its seat, it is generally somewhat difficult to get out. Often it is impossible to remove it by the ordinary means of tapping it and unscrewing with the fingers, and then most persons sacrifice the bottle by breaking off the neck. A glass-stoppered bottle that is so well ground as not to require the slovenly use of grease, or other aids to bad work, involves a good deal of skilled labour, and it is a real waste to destroy it, even if this can be done without any loss of the contents in breaking it. It is a fact not generally known that the very finest and most skilful stoppering that is practicable on a large scale and at moderate cost is not entirely effective against loss of many volatile liquids. A tray of fifty one-pound bottles of ether, kept in a cool cellar, and carefully weighed from time to time, lost at the rate of more than an ounce a month throughout the whole experiment, although stoppered as well as practicable, and never agitated. When agitated, as by transportation, and especially when transported in warm weather, the loss must be many times greater, and accidental imperfection in stoppering, or in the exposure of a box of bottles to a summer sun in long transportations, will occasionally cause the loss of a considerable part, or even the entire contents of some bottles, so that they reach their destination partly or entirely empty, but with little or no sign of leakage perceptible, so that the bottles look as though they had been put up partly full or empty. And leaks so small as not to be discoverable when put up are quite sufficient to empty a bottle during transportation. These difficulties are greatest with such liquids as chloroform, ether, and nitrite of amyl, and the latter is the most difficult of all. All these stoppers require to be put in as tightly as it is possible to put them in, and all stoppers are screwed in with what is called a stopper wrench, and such a wrench is needed to take them out. This is a piece of hard wood about 3½ inches long by about 1 or 1¼ inches in breadth and depth. In the middle of one side a mortise is cut nearly through just long enough and wide enough to admit the flat part of the largest size stopper. This applied to the stopper gives a very considerable leverage, and with it stoppers are screwed in by turning them in the direction of the movement of the hands of a watch, as all right-hand screws are put in. To take the stopper out it must, of course, be unscrewed or turned in the opposite direction. In this way almost all stoppers may be taken out safely if the neck of the stopper be strong enough to bear the strain, especially if the stopper be smartly tapped, first on one side and then on the other, by the wooden wrench before it is applied to unscrew it. But some liquids have a tendency to cement the stoppers into their seats either by drying in the joint or by a slight action upon the glass surfaces. Such liquids as solutions of soda and potassa, and especially the disinfectant solution of chlorinated soda, almost always render the stoppers immovable by any ordinary means, and even the stopper wrench will often fail to start them. It is highly probable that half the bottles used with such liquids are sacrificed before the contents can be got at, and in breaking off the necks the break often extends so that a part of the contents is liable to be lost.

When a stopper resists all management—by warming the neck with a cloth wet with hot water, by tapping, and by the wrench, or by all these in combination—there is another means which will almost always succeed. Let the bottle be inverted so as to stand on the stopper in a vessel of water, so filled that the water reaches up to the shoulder of the bottle, but not up to the label. The vessel should be so large that the bottle stands in an inclined position, or otherwise a portion of air may be trapped in the gutter between the mouth of the bottle and the stopper, and thus prevent the access of the water to the joint which is to be soaked out. The bottle should stand in this position over night, and if still refractory, for another day and night, and if still tight, three or more days, and in such cases the water should be warm at first and again quite hot for the last five minutes before the wrench is applied. There are many bottles which are very valuable, and the better the stoppering the more valuable they are. Almost all such may be saved by the means indicated, if the necessary time and patience be given.

Many bottles which are hardest to unstopper by reason of the action of the liquids on the glass are unfit for any after use, and might about as well be sacrificed as not, were it not for the liability of losing the contents in breaking them.

* From an "Ephemeris of Materia Medica, Pharmacy, Therapeutics, and Collateral Information," by Edward R. Squibb, M.D., Edward H. Squibb, S.B., M.D., and Charles F. Squibb, A.B. Brooklyn, N.Y., November, 1882.

NOTE ON THE PRECIPITATION OF STANNIC OXIDE FROM SODIUM STANNATE.

By PETER T. AUSTEN.

When a solution of sodium stannate is acidified, stannic hydrate is precipitated according to the formula—

$$SnO(ONa)_2 + H_2SO_4 = SnO(OH)_2 + Na_2SO_4.$$

The precipitate dissolves on addition of an excess of the precipitant. The precipitated stannic hydrate is voluminous, flocculent and gelatinous, resembling aluminic hydrate. So far as I have been able to ascertain, no other decomposition of the stannate, than in the manner indicated, has been effected.

I was surprised to find that, on passing a stream of carbonic acid through a strong solution of sodium stannate containing an excess of sodium hydroxide, a dense, heavy, and rapidly subsiding precipitate of stannic oxide was formed, the reaction being—

$$SnO(ONa_2) + CO_2 = SnO_2 + Na_2CO_3.$$

The same precipitation occurs when, instead of carbonic acid, the solution of sodium stannate is boiled with pulverised sodium hydrogen carbonate. In this case the reaction is—

$$SnO(ONa)_2 + 2NaHCO_3 = SnO_2 + H_2O + 2Na_2CO_3.$$

When dry, the precipitated SnO_2 forms a heavy white extremely fine powder. The reaction affords an excellent method of producing stannic oxide in quantity.—*American Chemical Journal.*

New Brunswick, N.J.

DETERMINATION OF BORACIC ACID.

By EDGAR F. SMITH.

When a solution of manganese sulphate is added to one of borax, and to this mixture an equal volume of alcohol, there separates rapidly a white flocculent precipitate of manganese borate, MnB_4O_7, insoluble in the alcoholic liquid. The excess of manganese sulphate remains in solution, and can readily be determined in the filtrate from the borate after the expulsion of the alcohol. To ascertain whether the above might be available quantitatively, the following solutions of definite strength were prepared, and the experiments recorded.

1. A solution of manganese sulphate, made by dissolving 3 grms. of anhydrous $MnSO_4$ in 250 c.c. H_2O. 10 c.c. of this solution would then correspond to 0·0600 grm. $MnSO_4$.

2. Potassium permanganate solution of such strength

that 18·5 c.c. were equivalent to 10 c.c. of I or 1 c.c. $KMnO_4 = 0·00324$ grm. $MnSO_4$.

3. Borax solution: 10 grms. well crystallised borax dissolved in 1 litre of H_2O.

The manner of conducting each experiment was as follows:—To 10 c.c. of the borax solution were added 10 c.c. $MnSO_4$ solution and an equal volume of strong alcohol. The whole was well mixed, allowed to stand, carefully covered, for one half-hour, when the manganese borate was filtered rapidly (best with a suction pump), and washed well with alcohol. The filtrate and washings were placed in a platinum or porcelain dish and evaporated to dryness on a water-bath. The residual manganese was then determined according to Volhard's method* by dissolving it in water, adding zinc-sulphate, then heating to almost boiling, and carefully running in potassium permanganate until the liquid assumed a pink colour. The quantity of manganese sulphate thus found and deducted from the whole amount of the salt added, gave a difference representing the manganese sulphate which had combined with the borax. After calculating the amount of manganous oxide to which the sulphate, found by difference, is equivalent, the following equations were employed:—

$MnO : 2B_2O_3 :: $ am't MnO : corresponding am't B_2O_3 (x);

and

Orig. sub. 10 c.c. borax solution : x :: 100 : y (per cent B_2O_3 in 10 c.c. of the borax solution).

Experiments.

Number of Anal.	Borax solution used.	$MnSO_4$ solution added.	No. c.c. $KMnO_4$ requ'd for excess of $MnSO_4$.	$MnSO_4$ in excess. Grm.	$MnSO_4$ in combination with B_2O_3. Grm.	Per ct. found of B_2O_3.
1.	10 c.c.	10 c.c.	6·4 c.c.	0·0207	0·0393	36·44
2.	,,	,,	6·1 ,,	0·0198	0·0402	37·27
3.	,,	,,	6·3 ,,	0·0204	0·0396	36·71
4.	,,	,,	6·3 ,,	0·0204	0·0396	36·71
5.	,,	,,	6·5 ,,	0·0210	0·0390	36·16
6.	,,	,,	6·4 ,,	0·0207	0·0393	36·44
7.	,,	,,	6·5 ,,	0·0210	0·0390	36·16
8.	,,	,,	6·4 ,,	0·0207	0·0393	36·44
9.	,,	,,	6·2 ,,	0·0201	0·0399	36·99
10.	,,	,,	6·3 ,,	0·0204	0·0396	36·71
11.	,,	,,	6·3 ,,	0·0204	0·0396	36·71
12.	,,	,,	6·4 ,,	0·0207	0·0393	36·44
13.	,,	,,	6·5 ,,	0·0210	0·0390	36·16
14.	,,	,,	6·3 ,,	0·0204	0·0396	36·71
15.	,,	,,	6·4 ,,	0·0207	0·0393	36·44
16.	,,	,,	6·3 ,,	0·0204	0·0396	36·71
17.	,,	,,	6·5 ,,	0·0210	0·0390	36·16
18.	,,	,,	6·4 ,,	0·0207	0·0393	36·44

The calculated percentage of B_2O_3 in borax is 36·60, and from the experimental results it will be observed that the method can be successfully applied in the analysis of soluble borates.

In estimating the boracic acid in insoluble borates, as tourmaline, the following course was pursued:—The finely pulverised substance was fused with a weighed quantity of pure sodium carbonate, the fused mass exhausted with water, and to the filtrate containing all the sodium borate, together with some sodium silicate and aluminate, was added an amount of pure ammonium sulphate molecularly equivalent to the sodium carbonate. The solution was then digested until all the ammonia was expelled and the volume of the liquid largely reduced. Any silicic acid or aluminum hydrate which had separated was now filtered off, and the precipitate thoroughly washed with hot water. The solution, again reduced in volume and containing only the borate and sulphate of sodium and excess of ammonium sulphate, was mixed with a definite amount of a manganese sulphate solution (strength previously determined), alcohol added, and after standing one half-hour the borate was removed by filtration, the filtrate evaporated to dryness, and the residue carefully ignited to expel the ammonium salt. The manganese sulphate left was dissolved in water, and the same procedure as indicated in the preceding experiments was carried out.

In a specimen of tourmaline from New York the boracic acid found by this method was 9·70 per cent. Another portion of the same material with Marignac's method* yielded 10 per cent B_2O_3. In another tourmaline (locality unknown) two determinations by this method gave 6·55 per cent B_2O_3 and 6·32 per cent B_2O_3, while with Marignac's method the amount obtained was 6·80 per cent B_2O_3.

In some instances upon evaporating the alcoholic solution preparatory to determining the excess of manganese sulphate, brownish flocks separated. These were always dissolved in a little sulphuric acid and then evaporated to dryness.

The writer is under many obligations to Messrs. N. Wiley Thomas, S.B., and W. H. Jarden, S.B., for their assistance in the execution of the details of the above method.—*American Chemical Journal.*

Muhlenberg College, Allentown, Pa., June 26, 1882.

* *Annalen der Chemie*, 198, 318.

ON THE REDUCTION OF FERRIC SOLUTIONS.

By PETER T. AUSTEN and GEO. B. HURFF.

ALTHOUGH numerous volumetric methods have been proposed and used for determining iron, there seems to be none that possesses the simplicity, accuracy, and elegance of the titration with potassium permanganate. In the analysis of iron ores by the use of this method, however, there are a few steps which are still open to improvement.

The remarkable discovery of Zimmermann,† that the addition of manganese sulphate to solutions of ferrous chloride entirely prevents the liberation of chlorine on the addition of potassium permanganate, thus making it possible to titre directly in a chlorhydric acid solution, has relieved the analysis of iron ores of one of its most irksome steps, the conversion of the chlorhydric acid solution into the sulphuric acid solution preparatory to reduction and titration with potassium permanganate.

The only remaining objection has been that the reduction of the ferrous solutions is liable to be unsatisfactory, either from incompleteness, danger of loss, or the length of time demanded. The reduction by zinc is objectionable because the zinc is liable to be impure, containing carbon or iron. A control determination of the iron can of course be made, and the amount introduced into the analysis deducted, but this is a method never advisable in analysis if it can be avoided, and in this case also increases the amount of work. If the solution is heated, oxidation easily takes place at the end of the reduction when all the zinc has been dissolved, while if an excess of zinc is used it takes time to dissolve the excess. If the excess is not dissolved, metallic iron may be precipitated.‡ Rose-Finkener§ suggests having the solution dilute and hanging a little stick of zinc in it by means of platinum wire, but it is doubtful if this method is very practical. The use of zinc dust as recommended by R. Drown‖ appears to us to be open to the objection just stated in regard to ordinary zinc, viz., that it often contains iron, thus rendering control determinations, deductions, and extra labour necessary. It is claimed for amalgamated zinc and platinum as an advantage that only pure zinc is dissolved, the impurities not passing into solution. A weighty objection to this method is, however, that so much time is lost by it. The reduction in this way always takes several hours; in fact one recent text-book¶ directs twenty-four hours. Mag-

* *Zeitschrift fur analyt. Chemie*, 1, 405.
† *Ber. d. d. chem. Ges.*, 14, 779.
‡ Mitscherlich, *Zeit. anal. Chem.*, 2, 72.
§ Rose, "Quant. Anal.," 1871, 100.
‖ *Zeit. anal. Chem.*, 18, 98.
¶ Cairns, "Manual of Quant. Anal.," p. 45.

nesium reduces well, but has the disagreeable property of floating on the surface. The reduction with hydrogen sulphide* requires a tedious evaporation.

It was our endeavour, therefore, to find some method by which ferric solutions could be quickly reduced and which would require no corrections. The following procedure was found to answer admirably.

The ferric chloride solution, which should contain about 5-10 c.c. of free chlorhydric acid and about 0·1 grm. of metallic iron in 100 c.c., is placed in a 300 c.c. flask with a long neck, diluted to 200 c.c., and heated nearly to boiling. The heat is then removed, and a saturated solution of sodium sulphite is added in small amounts (about 1 c.c. at a time) till 15-20 c.c. in all have been used. While adding the sulphite, it is well to give the ferric solution a revolving motion by gently twirling the flask. The solution becomes colourless, showing that all the ferric chloride is reduced to ferrous chloride. The sodium sulphite which we use is obtained by re-crystallising the pharmaceutical article, and forms beautiful crystals which are perfectly free from iron. As soon as the solution of the sulphite has all been added, a rubber stopper and tube† are inserted, the pinch-cock *b* opened, and the liquid heated to boiling and kept at a brisk boil.

It is of course necessary that the last traces of sulphurous acid should be entirely expelled before titration, since any of it remaining would be oxidised by the permanganate and counted as iron. To ascertain if the steam is entirely free from sulphurous acid it is allowed to pass into a test-tube containing about 50 c.c. of water to which a little sulphuric acid and a drop of potassium permanganate solution has been added. If there is the slightest trace of sulphurous acid in the steam the liquid will at once be decolourised. If the steam is allowed to pass for some time through this solution of permanganate, it will decompose it, but this does not interfere in any way with the sharpness of the test. As soon as the test shows that the sulphurous acid has all been driven off, the end of the tube is washed off with a little hot water, the heat removed, and the pinch-cock *b* closed. The end of the tube is allowed to dip into a beaker of cold distilled water. As soon as the flask has cooled enough to have a vacuum within it, which generally occurs in a few minutes, the clip is opened and the cold water allowed to run in in portions so as to thoroughly wash out the tube. The flask is allowed to fill till the liquid stands at about the beginning of the neck. The clip is then closed, the right-hand tube removed and the contents of the flask cooled‡ under the tap. The manganese sulphate is next added and the titration proceeded with.

The above method of procedure works as well with sulphuric acid solutions as with chlorhydric acid solutions. The reduction and titration together take from fifteen to twenty minutes. A number can of course be run at the same time. The following experiments show the accuracy of the method:—

Subs. taken.	Weight taken.	Per ct. of Fe found.	Per ct. of Fe calc.	Difference. Per cent.
Ammonium-Iron Alum	1	11·529	11·618	−0·089
„ „	1	11·649	„	+0·031
Ammonium-Ferrous Sulphate	1	14·291	14·285	+0·006
„ „	1	14·291	„	+0·006

In another series of experiments 0·2 grm. of pianoforte wire was dissolved in dilute chlorhydric acid, diluted to about 150 c.c., oxidised with permanganate, the chlorine boiled off and then reduced in the manner described above. The titrations required the same number of c.c. of permanganate as the same amount of the same iron used in setting the standard of the permanganate, viz., 16·5-16 6.

If iron alone is to be determined in an iron ore, it is not necessary to separate the silica when the ore is decomposed by chlorhydric acid. The very finely pulverised ore is simply boiled with concentrated chlorhydric acid till decomposed, the resulting liquid and silica washed into a flask and the solution reduced and titered as described. When it is necessary to use a flux it is advisable to separate the silica.—*American Chemical Journal.*

* Fresenius, "Quant. Anal.," last Am. ed., p. 279.

† Fresenius, "Quant. Anal.," last Am. ed., p. 268, Fig. 51. In our apparatus, the right-hand tube is bent at about an inch from its junction with the rubber connection.

‡ To obtain sharp results by Zimmermann's method it is necessary that the solution should not be warm..

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, December 9th, 1882.

Prof. Clifton, President, in the Chair.

New members—Mr. H. E. Harison, B.Sc.; Mr. S. T. H. Saunders, M.A.

Prof. G. Forbes read a paper on the "*Velocity of Light of Different Colours.*" The author concluded from his experiments, described to the Society a year ago, that blue rays travel quicker than red rays. M. Cornu had endeavoured to explain this result by peculiarities of the apparatus employed, but this explanation seemed doubtful. It was suggested that the experiments might be repeated with such modifications of the apparatus as would set the question at rest.

Profs. Ayrton and Perry read a paper on the "*Resistance of the Voltaic Arc, or the Opposition Electromotive Forces set up.*" The electromotive force was measured by a voltmeter connected between the terminals of the lamp. Keeping the width of arc constant the E.M.F. was found to diminish as the current increased. Keeping the current constant the E.M.F. increased rapidly at first with an increasing width of arc, and afterwards more slowly. The authors gave a curve representing the change. About 80 volts are required to produce an arc of $\frac{1}{3}$ inch. For further increase of arc, E.M.F. is therefore proportional to increase of length of arc.

The authors also read a paper on the "*Relative Intensities of the Magnetic Field produced by Electro-magnets when the Current, Iron Core, and Length of Wire, &c., are Constant, but the Wire Differently Distributed.*" In (*a*) case the wire was wound uniformly from end to end; in (*b*) case it was wound from the middle to one end; in (*c*) case it was wound only at both ends; in (*d*) case it was wound only at one end. The field was measured along a line running through the axis of the poles beyond the magnet. Of the above plans, *a* gave the strongest field except at short distances, when *b* was best.

Profs. Ayrton and Perry also exhibited a set of three Faure accumulators, in series feeding 20 Swan lamps, each lamp giving over one candle-power. The electromotive force of each cell was about 2 volts.

Next meeting January 27, 1883.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, October 17, 1882.

H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

"*Note on the Development of Living Germs in Water,*" by Dr. R. Angus Smith, F.R.S.

In a Report on proceedings under the Rivers Pollution Prevention Act, I mention my wish to develop germs of living things in water as a test for purity. The quotation

is from a paper printed by this Society in 1867. The results were correct and useful, but not striking enough to attract much attention, although I think chemists have not been sufficiently active in using the microscope. Having long seen its importance, I confess to having done too little with it. In a Report under the Alkali Act during the year 1873, I mention a second attempt to render the existence of organic matter more perceptible by using the air washings to act upon sugar, and after many trials I was disappointed; still I came to the conclusion "that the air of a town influences fermentation to a certain extent."—Tenth Report, p. 43.

I neglected this development also too much, but Dr. Koch, of Berlin, has shown us how to preserve the indications of organic vitality by the use of gelatin. I believe he was the first to use it. It is from Dr. Koch, at any rate, that I learned the use of gelatin. About 2½ per cent of gelatin well heated in a little water is mixed with the water to be tested, and the mixture forms a transparent mass, which is not movable like the water itself. When soluble or unobserved matter develops from the organic matter of the waters and makes itself visible in a solid and insoluble form, it does not fall to the bottom, but each active point shows around it the sphere of its activity, and that sphere is observed and remains long. The gelatin preserves to us the whole action, so far as the more striking results are concerned, and keeps a record, for a time, both of the quality and intensity of life in the liquid. I speak at present of the more striking effects, which are clear and abundant, every little centre of life making itself clear to the eye, and sometimes expanding its influence to reach both sides of the tube. It seems to me now essential that all chemical examinations of water should be supplemented by an enquiry, like this of Dr. Koch's, into the comparative activity of the living organisms. How far this may go it would be absurd to attempt to say, and I never have much hope of a man who writes about the future of truth; he evidently attempts too much. I am satisfied to bring forward such facts as I know in the present, so that chemists may not be too late in attending to the new ideas.

The water must not have too much gelatin in it, if so the action is stopped. It must not have too little, if so the gelatin becomes liquid too soon and the action of the individual centres is not observed. When a centre acts it makes around it a sphere in some waters, and the sphere, which has the appearance of a thin vesicle, is filled with liquid. These spheres form in a day or two, according to the water, and at the bottom is a white mass containing active bacteria chiefly. The liquid filling the spheres may be taken out by a pipette and examined, as also the bacteria which lie at the bottom.

I have not examined a sufficient number of waters to give general rules, but I hope to do so. It is an investigation which would properly belong to Prof. Koch, and I should not have touched it had I not found that it brought into use my own enquiries as to fermentation, which were earlier, but may now be considered only a supplement to Dr. Koch's. This is by the use of sugar in addition to the gelatin. By this means a very great amount of gas is developed and retained in the gelatin. The striking amount of spheres and gas bubbles render the examination of water by this method less dependent on the opinion of the operator, and a photograph may be taken of each specimen and the result preserved as evidence.

At the same time I know that it is necessary to examine waters of various kinds before we make or find rules, and this slight account is a mere beginning. I have as yet examined no chalk water, for example, but have been confined chiefly to the Manchester district, hill water, impure brook and pond water, Mersey, Irwell, and Medlock water, and canal water. In certain specimens of Manchester supply the spheres appear on some days very few, on other days the amount is enormous and heavy; the whole of the tube in which the experiment is made is filled with spheres. At such times the water is highly impure and complained of by the public. We have a very easy proof therefore of the value of this test.

The photograph would be a visible report made by nature when the water has active organisms in it. The globules do not show themselves in strong sewer water, but the whole mass becomes turbid and the surface of the gelatin becomes liquid and full of life. This liquid condition gradually increases until the whole is reached. We have therefore two striking conditions well marked out.

A third may be said to exist, but it is often a mere beginning of the globules. This is shown by the formation of a small white opaque point. If this point is examined it is seen to be full of life like the lower part of the spheres and the fluid portion of the gelatin when this fluidity begins on the surface.

I find, also, that the solidity or fluidity of the gelatin is an important indication. This is known by the depth to which a certain weight will sink in it.

I use the word bacteria at present because, although I have observed various forms, I do not intend to investigate the separate functions of each.

At present this mode of examining water seems to me to be far more important than the chemical, more decided and telling, but we cannot neglect the chemical.

An account of a few specimens is given here.

Specimen 1.—25 c.c. gelatin solution = 2½ p.c. solid + 25 c.c. distilled water + 5 m.grms. sodium phosphate.

After two days a few white spots appeared.

After three days 3 or 4 small spheres appeared, containing living bacteria.

After four days spheres enlarged, and a deposit forming at the bottom of them very full of bacteria.

After six days the surface of the jelly was beginning to give way.

After eight days the surface layer was liquid to the depth of a millimetre, but the rest of the gelatin was still firm, with no smell; liquid layer alkaline.

Specimen 2.—25 c.c. gelatin + 25 c.c. Manchester water + 5 m.grms. sodium phosphate.

After one day the tube contained a few minute specks.

After two days a number of minute spheres, not to be counted, appeared, and a turbid band was formed near the surface of the jelly, which was very rich in living bacteria.

After three days spheres became larger and the whole of the gelatin was softened; a number of air bubbles appeared also.

After four days air spheres had risen to surface, bacteria spheres disappeared, leaving the liquid jelly turbid, and smelling offensively; liquid alkaline.

Specimen 3.—25 c.c. gelatin + 25 c.c. Manchester water + 5 m.grms. sodium phosphate after filtration through spongy iron.

The result here resembled that of the distilled water.

25 c.c. gelatin + 25 c.c Mersey water at Northenden + 5 m.grms. sodium phosphate.

After one day a turbid band appeared near the surface and a number of minute spots appeared.

After two days these spots had spheres about them.

After three days the surface layer was quite liquid and turbid and a number of discs of gas appeared. Bacteria in spots, and surface liquid.

After four days, in a somewhat similar condition, but the surface liquid possessed a very disagreeable smell.

Specimen 4.—25 c.c. gelatin + 25 c.c. Bridgewater Canal water + 5 m.grms. sodium phosphate.

After two days a number of spots appeared dispersed throughout the tube.

After three days the tube contained one mass of small spheres and spots.

After four days a number of discs of gas appeared, the surface layer was becoming liquid.

Specimen 5.—25 c.c. gelatin + 25 c.c. Birch pond water + 5 m.grms. sodium phosphate.

After one day no alteration.

After two days a few specks appeared dispersed throughout the jelly.

After three days a number of spots appeared and discs of gas, surface layer of jelly becoming liquid.

A disc of gas is formed when the gelatin remains firm, and the gas struggles for freedom.

Specimen 6.— 25 c.c. gelatin + 25 c.c. Carlile's pond water, near Alexandra Park + 5 m.grms. sodium phosphate.

After one day specks appeared dispersed throughout the gelatin.

After two days numberless very minute spheres appeared.

After four days the spheres had increased in size.

After seven days a number of spheres of gas appeared.

Specimen 7.—25 c.c. gelatin + 25 c.c. ditch water, near Alexandra Park + 5 m.grms. sodium phosphate.

After one day a number of specks appeared throughout the jelly.

After two days numberless spheres appeared.

After three days the surface of the jelly had become liquid and turbid; the spheres were increasing in number.

After seven days a number of spheres of gas appeared and the whole mass was becoming liquid.

Specimen 8.—25 c.c. gelatin + 25 c.c. N. Berwick water supply + 5 m.grms. sodium phosphate.

After one day the tube seemed one mass of minute specks.

After two days a number of minute spheres appeared and a turbid band appeared near the surface of the gelatin.

After three days, spheres had increased in size; a number of discs of gas appeared.

After four days the spheres were disappearing; the surface of the jelly was becoming liquid (these spheres did not leave a deposit).

After eight days the surface layer was quite liquid, but the rest of the jelly was firm, and there were still left a number of discs of gas and a number of minute spots; smell offensive.

Specimen 9.—25 c.c. gelatin + 25 c.c. Stockport water supply + 5 m.grms. sodium phosphate.

After one day a number of minute specks appeared and a few small discs of gas.

After two days these discs of gas were getting larger, and on the third day the tube was one mass of discs of gas.

After five days the jelly was liquid and the discs of gas rose to the surface when shaken; smell disagreeable.

Specimen 10.—25 c.c. gelatin + 25 c.c. Medlock water + 5 m.grms. sodium phosphate.

After one day a number of spots appeared dispersed throughout the jelly.

After two days these spots were more decided and a distinct turbid band appeared at the surface of the jelly.

After three days a number of flattened discs of gas appeared; surface layer semi-liquid and turbid.

Specimen 11.—25 c.c. gelatin + 1 c.c. hay infusion + 24 c.c. distilled water + 5 m.grms. sodium phosphate.

After one day the surface layer of the jelly was altering; the layer was becoming turbid and liquid.

After two days the alteration was still more advanced, but the surface layer was not yet liquid.

After three days the surface layer was liquid.

After seven days a great deal of the jelly had become liquid, and white specks appeared dispersed throughout the jelly.

Specimen 12.—5 c.c. gelatin + 1 c.c. putrid urine + 24 c.c. distilled water + 5 m.grms. sodium phosphate.

After one day the surface layer was becoming turbid and liquid.

After two days, the alteration more advanced; surface of jelly semi-liquid.

After three days the jelly at the surface was quite liquid, turbid, and offensive.

This subject is being more fully developed under Dr. Koch by Dr. Rozahegyi, and chemists must prepare for a new condition of things.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 21, November 20, 1882.

The Volta Prize.—The prize of 50,000 francs instituted by the decree of June 11, 1882, in favour of the author of the discovery which shall enable electricity to be applied economically in one of the following directions: As a source of heat, of light, of chemical action, of mechanical power, as a means of the transmission of intelligence, or of the treatment of disease, will be awarded in December, 1887. The *savants* of all nations will be admitted to compete up to June 30, 1887. A commission nominated by the Minister of Public Instruction will be charged with examining the invention specified by each candidate, and of recognising whether it fulfils the conditions required.

Results of Experiments made at the Electric Exhibition on Incandescence Lamps.—MM. Allard, F. Le Blanc, Joubert, Potier, and H. Tresca.—Continued from the last number.

Researches on Lead Iodide.—M. Berthelot.—The author has obtained two double iodides by dissolving lead iodide in a hot concentrated solution of potassium iodide. For the first of these he gives the formula PbI,KI,2HO, and for the second, which is obtained at lower temperatures in long acicular crystals of a pale yellow, 2KI,3PbI,6HO. These two salts combine with each other. The author has examined the thermic phenomena which accompany their formation.

Decomposition of Cyanogen.—M. Berthelot,—The author has studied the decomposition of cyanogen by an almost continuous stream of electric sparks.

Optical Researches Relative to the Vision of Colours.—M. Chevreul.—The author gives an account of the dates of publication of his researches, touches on avic acid, points out the difference between organic chemistry and the chemistry applied to organic beings, which he teaches at the Museum, and at last enters upon botanical and zoological classification.

Chemical Studies on the Sugar-Beet.— Hippolyte Leplay.—A continuation from the last number.

Electro-chemical Deposits of Various Colours produced upon the Precious Metals.—F. Weil.—The author exhibited specimens of gold and silver jewelry, poly-chromised by his process. These colourations resist friction, moisture, air vitiated by sulphuretted hydrogen, coal-gas, &c.

A Sulpho-carbometer for Determining the Quantities of Carbon Disulphide contained in the Alkaline Sulpho-carbonates.—MM. A. Gélis and Thommeret-Gélis.—This instrument cannot be usefully described without the accompanying cut.

Action of Tri-ethyl-amine upon Symmetric Tri-chlor-hydrine, and on the Two Isomeric Di-chlor-hydric Glycides.—E. Reboul.—Instead of fixing 2 mols. of tri-ethyl-amine, symmetric tri-chlor-hydrine loses hydrochloric acid. The two isomeric di-chlor-hydric glycides resulting from this elimination follow the law of the hydrochloric ethers of the primary mono-atomic alcohols, and simply fix tri-ethyl-amine.

Production of certain Crystalline Uranates by the Dry Way.—A. Ditte.—The author gives three methods by which potassium, rubidium, lithium, and magnesium uranates can be obtained in fine yellow tables, more or less tinged with green, insoluble in water, and infusible at a white-red heat. One of the methods is by heating the

oxide U_3O_4 with sodium chloride. The uranium oxide is decomposed, and gives off oxygen, which, with the salt and the sesquioxide, forms sodium uranate. The chlorine given off at the temperature of the experiment attacks neither the oxides nor the platinum crucible. Calcium uranate is formed by heating the green uranium oxide with pure calcium chloride. There is formed a ring of crystals, which, when purified by washing with water, are calcium uranate. Strontium and barium uranates are formed in the corresponding manner.

Note on the Measurement of Schistosity in Schistous Rocks by means of their Thermic Properties.—E. Jannettaz.—Not adapted for abstraction.

Lithia, Strontia, and Boric Acid in the Mineral Waters of Contrexeville and of Schinznach.—M. Dieulafait.—The waters of Schinznach, which are mineralised in the Trias, contain, like all waters of this class, the three bodies above mentioned.

Calcination of Alunite in Powder, intended for the Manufacture of Alum and of Aluminium Sulphate.—P. Guyot.—The author finds that a temperature of 800° gives the best results, since almost all the alumina is then found in a state capable of being attacked by acids, whilst little potassium sulphate is left in the insoluble alum.

Journal für Praktische Chemie.
New Series. Vol. xxvi., Nos. 15 and 16.

Certain New Amidic Acids, Synthetically Prepared, and Analogous in Constitution to Hippuric Acid.—Theodor Curtius.—The author gives a convenient process for purifying crude hippuric acid; a method of obtaining glycocoll from hippuric acid; contributions to the knowledge of amido-acetic acid; a process for obtaining pure silver amido-acetate; an account of the action of chlor-benzoyl upon glycocoll silver; a description of synthetic hippuric acid and its accompanying β and γ acids. He further describes the former, as hippuryl-amido-acetic acid, its derivatives, and its silver, thallium, barium, copper, and zinc salts, its ethyl-ether, and its derivative, hippuryl-glycoll-amide. He adds a tabular view of certain reactions of glycocoll, benzoyl-glycocoll, hippuryl-glycocoll, and the γ acid.

Formation and Decomposition of Acetanilide.—N. Menschutkin.—In this memoir the author treats of the speed of the formation of acetanilide, and the influence of temperature upon it. He gives proof of the presence of a limit in the formation of acetanilide from acetic acid and aniline, and the influence of temperature upon the changes of this limit. He then considers the decomposition of acetanilide by water, and the influence of the chemical mass of the aniline and acetic acid upon the distribution, the modification of speed, and the limit of he formation of acetanilide.

The Hydrates of Glucinum Oxide.—J. M. van Bemmelen. — Glucinum hydroxide resembles magnesium hydroxide more in its granular than in its gelatinous state. The former, on prolonged heating to 220°, undergoes the same changes which with magnesia only occur on intense ignition. The β-glucinum hydroxide is more similar to the sesqui-hydroxides, such as those of aluminium, &c., whilst the α-hydroxide approaches the mono-hydroxides, such as those of calcium and magnesium. The hydrate α behaves more like an ordinary chemical compound. Its composition can be expressed in a formula with simple numerical proportions, and within certain limits of temperature its composition is constant. The hydrate β does not possess the two above-named properties, and it agrees in this respect with the gelatinous hydrates of ferric oxide, &c.

The Volume-Weight of Mono-hydrated Sulphuric Acid.—Arn. Schertel.—The most concentrated acid obtained by evaporation or which passes over last on distillation with a constant composition is the acid of the highest specific gravity. The liquid mono-hydrate undergoes decomposition even at 0°, or close upon its freezing-point.

Moniteur Scientifique, Quesneville.
November, 1882.

A New Law Analogous to the Law of Avogadro.—J. A. Groshans.—The author proposes the law: "At the temperature of ebullition the density of compound bodies is proportional to the sum of their atoms." As immediate corollaries he adds that for bodies of the general form $CpHqOr$ the sum of the atoms is expressed by $p+q+r=n$; $p'+q'+r'=n'$. The proportion of the densities is therefore that of $n : n'$. The new law is applicable to bodies in the gaseous or the liquid state. It applies not only to bodies at the boiling-point, but more generally to all corresponding temperatures. The analogy between the new law and that of Avogadro lies in the circumstance that both regard the densities of bodies in the gaseous state; the latter, that of Avogadro, compares the densities at equal pressures and temperatures. The densities are then proportional to the molecular weights. The new law compares densities at equal pressures, but at different temperatures—at so-called corresponding temperatures, such as their boiling-points. The densities are then proportional to the sums n, n' of the component atoms. There are, however, certain divergences between the two laws: 1. The law of Avogadro considers bodies exclusively in the gaseous state, whilst the new law applies as well to the densities of liquids as to those of gases. 2. The new law divides bodies into numerous different categories, whilst the law of Avogadro seems not to do the same. The great majority of known bodies form a single category subject to this law.

Review of Biological Chemistry.—G. de Bechi and H. Gall.—A number of translations from German journals, some of which are not very recent.

Analysis of the Report of the International Jury on the Chemical Processes of Bleaching, Dyeing, Printing, and Finishing at the Exhibition of 1878.—This report appearing four years after the event contains mention of no essential modification in dyeing and printing processes. We find it stated, without any expression of censure or protest, that certain processes for black dyeing produce 400 lbs. of *something* from 100 lbs. of silk.

Determination of Sugars by Polarised Light.—E. Lebaigue.—The author gives procedures for saccharose, glucose, and for mixtures of saccharose, glucose, and levulose.

Industrial Society of Mulhouse.—Meeting of the Chemical Committee, September 13, 1882.—M. Rosenstiehl exhibited the plates which are to accompany his work on the sensations of colour.

M. Jaquet read the following note on the formation of chrome yellow (lead chromate) by steaming. This process is based upon the solubility of metallic citrates in alkaline citrates, and particularly in ammonium citrate. This property applies not merely to the metallic citrates, but to a number of other salts. Thus in presence of an alkaline citrate baryta is not precipitated by sulphates, nor potassium ferrocyanide by the ferric salts. The insoluble chromates are all more or less dissolved by ammonium citrate, and in general more in heat than in the cold. Zinc chromate, among others, which is little soluble when cold, dissolves with great readiness when heated. Lead chromate, on the other hand, is dissolved with much more difficulty. On submitting to the action of steam a colour composed of lead citrate, ammonium citrate, and zinc chromate, a lead chromate yellow is obtained almost as solid as that produced by dyeing. By the action of steam the lead citrate and zinc chromate dissolve in the ammonium citrate, and give by double decomposition zinc citrate and lead chromate, which is

fixed upon the fibre. The author exhibited a swatch which had been soaped at a boil for half an hour. It may be foreseen that solid greens may be obtained by adding to the colour alizarin blue.

December, 1882.

Ultramarine. — G. Guckelberger. — This extensive treatise has already appeared in *Liebig's Annalen*.

Review of Foreign Researches.—G. de Bechi.—A series of translations almost exclusively from the *Berichte der Deutschen Chem. Gesellschaft*.

The Specific Rotatory Power of Glucose.—H. Gall.—A critique on the paper by M. E. Lebaigne, in the November number. The author repudiates M. Lebaigne's correction of the figure generally received for the rotatory power of glucose.

Bulletin de la Société Chimique de Paris.
Nos. 6 and 7, October 5, 1882.

The Decomposition of Copper Acetate in Presence of Water.—D. Tommasi.—If we heat in a sealed flask on the water-bath a very dilute solution of copper acetate, containing 1 or 0·5 per cent, or even less, of the salt, we obtain acetylene among the products of decomposition. This hydrocarbon is not formed in concentrated solutions of the same salt.

Russian Chemical Society.—Meeting of Jan. 7/19, 1882.—The President, M. Boutleroff, announced that the Sokoloff prize has been awarded to M. Menschoutkine for his researches on the influence exerted by the isomerism of the alcohols and acids on the formation of the compound ethers.

The Secretary announced that MM. Beilstein, Latchinoff, and Mendelejeff are elected members of the commission for awarding the Ragosine prize, relating to lamps for burning the heavy petroleum oils.

M. Menschoutkine gave an account of the etherification of the acids with double functions.

M. Potilitzine sent in a communication on the influence of masses in the reciprocal substitution of the haloids. When a quantity of bromine greater than an equivalent is caused to act upon the metallic chlorides, the influence of the atomic weight and of the atomicity is found to be the same as when the bodies are taken in equivalent quantities.

M. Lubavine described an ore containing iron and manganese, and found immediately under the arable soil in the neighbourhood of St. Petersburg.

M. Schalfeeff made a preliminary communication on the atomic volumes of the elements.

M. Alexeeff communicated the conclusion of his researches on the reciprocal solubility of liquids. He distinguishes two sorts of solutions: the one kind formed of liquids whose reciprocal solubility is considerable, and which possess the property of mixing in all proportions at relatively low temperatures; the others have a less considerable solubility, and are incapable of mixing in all proportions at any temperature soever.

M. Louguinine exhibited the apparatus which he has constructed for determining the specific heats of solids and liquids.

M. Goldstein exhibited an apparatus for washing liquids insoluble in water.

M. Stcherbatcheff described a process for purifying water so as to avoid boiler incrustations.

M. Mendelejeff described his researches on the products of distillation of six varieties of Caucasian petroleum. The light products contained in these varieties are all identical. The fraction boiling at 100° to 105° has a specific gravity of 0·751 to 0·758, whilst the fraction of American petroleum boiling at the same temperatures does not exceed 0·703 to 0·710.

Meeting of February 1/16, 1882.—M. Selezneff sent in researches on the action of sulphur upon glass.

M. Kalantaroff sent in the results of the analyses of certain Russian cheese.

M. Menschoutkine explained an attempt at determining the chemical value of the components of acids.

M. Latchinoff described the characters of iso-cholalic acid.

M. Mendelejeff exhibited an apparatus for demonstrating the phenomenon of the diffusion of gases.

M. Alexeeff described his researches on phenol hydrate. He has also studied the influence of the physical state of a substance upon its solubility, He considers that the solution of a body does not necessarily contain it in a liquid state.

M. Laboudsky described the product formed at the expense of the combined carbon of cast-metal when decomposed by mercuric chloride.

M. Wagner gave a communication on the law of the oxidation of acetones announced by M. Popoff.

Nos. 8 and 9, November 5, 1882.

Double Salts formed by the Haloid Salts of Mercury.—M. Berthelot.—A thermo-chemical paper which has already been briefly noticed.

Russian Chemical Society.—Session March 4/16, 1882.—M. Mendelejeff, on behalf of the Commission for examining lamps for burning the heavier petroleum oils, reported that none of them fulfilled the conditions of the Ragosine prize.

M. Radoulowitch sent in a memoir on the formation under certain conditions of hydrogen peroxide in the oxidation of terebenic carbides.

M. Bardsky had experimented on the oxidation of essential oils in contact with air.

M. Menschoutkine communicated certain facts relating to the application of the theories of Bergmann and Berthollet to chemical reactions. The author has studied the action of two different bases upon the same acid, the bodies reacting being taken in molecular quantities, and forming a homogeneous system during the whole duration of the experiment. According to the nature of the bases and of the acids he has observed either a complete displacement of one base by the other, conformably to the theory of Bergmann and the principle of maximum work of M. Berthelot, or a distribution of the acids between the bases according to Berthollet. None of these theories taken separately suffices to explain the experimental results.

M. Kabloukoff announces that on passing a mixture of the vapours of methylic alcohol and of air through a heated tube filled with platinised asbestos, he obtains notable quantities of oxy-methylene.

According to M. Loubavine the crystalline acid resulting from the action of ammonium cyanide and sulphuric acid upon glyoxal, is glycocoll.

M. Loubavine proposes a formula for glyoxaline based upon the researches of M. Goldschmidt.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., September, 1882.

This issue contains no chemical matter with the exception of a paper by Dr. G. Lunge on the German alkali industry, taken from the *Journal of the Society of Chemical Industry*.

MEETINGS FOR THE WEEK.

THURSDAY, 28th.—Royal Institution, 3. "Light and the Eye," by Professor Tyndall.
—— London Institution, 7.
SATURDAY, 30th.—Royal Institution, 3. "Light and the Eye," by Professor Tyndall.

ERRATA.—Page 272, col. 1, line 12 from top, *for* 0·37 *read* 0·037; col. 2, line 5 from top, *for* 0·5 *read* 0·05.

THE CHEMICAL NEWS.

Vol. XLVI. No. 1205.

ON THE ORIGIN OF THE HYDROCARBON FLAME SPECTRUM.*

By G. D. LIVEING, M.A., F.R.S., Professor of Chemistry, and J. DEWAR, M.A., F.R.S., Jacksonian Professor, University of Cambridge.

In previous communications† to the Society we have described the spectra of what we believe to be three compound substances, viz., cyanogen, magnesium-hydrogen, and water.

In these investigations our chief aim has been to ascertain facts, and to avoid as far as possible adopting any special theory regarding the genesis of the spectra in question. Thus, in speaking of the magnesium-hydrogen spectrum, which consists of three sets of flutings closely resembling in character the flame spectrum of hydrocarbons, we remark:—"We have been careful to ascribe this line and its attendant series to a mixture of magnesium and hydrogen rather than to a chemical compound, because this expresses the facts, and we have not yet obtained any independent evidence of the existence of any chemical compound of those elements."

In dealing with the cyanogen spectrum, we sometimes refer to it as the "nitro-carbon spectrum," in order to convey that "we are dealing with a spectrum invariably associated with the presence of nitrogen and carbon, in such conditions that chemical union takes place." Finally, in summing up our observations on the spectrum of water, we remark:—"In writing of this and other spectra which we have traced to be due to compounds, we abstain from speculating upon the particular molecular condition or stage of combination or decomposition which may give rise to such spectra."

The difficulties we have met with in endeavouring exhaustively to clear up many apparently simple spectroscopic problems, on a basis of fact as opposed to theory, is further illustrated in the concluding remarks of our paper entitled "Investigations on the Spectrum of Magnesium," wherein the following passage occurs:—"The chemical atoms of magnesium are either themselves capable of taking up a great variety of vibrations, or are capable by mutual action on each other, or on particles of matter of other kind, of giving rise to a great variety of vibrations of the luminiferous ether; and to trace satisfactorily the precise connection between the occurrence of the various vibrations and the circumstances under which they occur, will require yet an extended series of observations." (*Proc. Roy. Soc.*, vol. 32, p. 203).

Specific spectra have been satisfactorily proved to emanate from the compound molecules of cyanogen, water, and magnesium-hydrogen, so far as we can interpret in the simplest way the many observations previously detailed. The fact that a fluted spectrum is produced under certain conditions, by a substance which does not give such a spectrum under other conditions, is of itself a proof that the body has either passed into an isomeric state or has formed some new compound; but we are not entitled to assert, without investigation, which of these two reasonable explanations of the phenomena is the true one. There is, however, a spectrum to which we have had occasion to refer in the papers on the spectra of the compounds of carbon, which closely resembles that of a compound substance, and which we, in common with some other spectroscopists, have been led to attribute to the hydrocarbon acetylene, without, however, being able to bring forward such rigid experimental proofs of its origin as we have adduced in the case of the three substances above referred to. In other words, the experimental evidence that the hydrocarbon flame spectrum was really due to a hydrocarbon was always indirect. Thus, we showed that many flames containing carbon, such as those of hydrogen mixed with bisulphide of carbon or carbonic oxide, and the flame of cyanogen in air, did not give this spectrum, and these particular flames are known, from the investigations of Berthelot, to be incapable of generating acetylene under conditions producing incomplete combustion. On the other hand, we found that a flame of hydrogen mixed with chloroform, which easily generates acetylene, gives the hydrocarbon flame spectrum in a very marked manner, and it is known that the ordinary blowpipe flame, in which the same spectrum is well developed, contains this hydrocarbon.

These and other experiments point to the intimate relation of hydrogen and carbon in the combined form of acetylene to the production of this spectrum during combustion. In our various observations on the spectrum of the electric arc taken in different gases, the flame spectrum was always noticed, and seemed to be independent of the surrounding atmosphere. In the mode in which those experiments were conducted, it was easily shown that the carbons were never free from hydrogen, and that the gases always contained traces of aqueous vapour. Under these conditions acetylene is formed synthetically during the electric discharge, the line spectrum of hydrogen being absent; so that we were never convinced that the spectrum was not due to the former substance.

It is well to remark in passing, that our previous work on the spectrum of the carbon compounds was mainly directed to that particular spectrum which is characteristic of the flame of cyanogen, and only indirectly to the flame spectrum of hydrocarbon. We were further supported in connecting the latter spectrum with acetylene, by observing that cyanogen compounds are continuously formed when the arc discharge takes place in gases containing nitrogen, and that in all probability their formation is due, as Berthelot has shown, to a reaction taking place between acetylene and nitrogen. Berthelot is positive in his assertions that cyanogen is never formed by a direct combination between carbon and nitrogen, and any such apparent combination is due to impure carbon, and the presence of an imperfectly dried gas; in other words, hydrogen is essential to the production of cyanogen under such conditions according to the views of Berthelot. Such considerations led us to suggest the following view, expressed at the time the experiments were made, as to the origin of the hydrocarbon flame spectrum.

"The mere presence of the latter spectrum feebly developed in the electric discharge in compounds of carbon supposed to contain no hydrogen, appears to us to weigh very little against the series of observations which connect this spectrum directly with hydrocarbons." (*Proc. Roy. Soc.*, vol. 30, p. 160).

"The arc in the middle of a magnesia crucible often shows no trace of the hydrocarbon set, although the cyanogen are strong. If, however, puffs of air or carbonic acid are passed into the arc, the hydrocarbon lines are produced."

"When the hydrocarbon spectrum is strong the brilliancy and number of the cyanogen groups that are visible are undoubtedly increased, so that the one variety of vibrations seems to affect the other. This is easily accounted for by the chemical interaction which takes place between acetylene, nitrogen, and hydrocyanic acid. The hydrocarbon spectrum is brought out at once in the magnesia crucibles by moistening one of the poles. All

* A Paper read before the Royal Society, Dec. 22, 1882.

† "On the Spectra of the Compounds of Carbon with Hydrogen and Nitrogen." I. and II. *Proc. Roy. Soc.*, vol. 30, pp. 152, 494. "On the Spectrum of Carbon," *Ibid.*, vol. 33, p. 403. "General Observations on the Spectrum of Carbon and its Compounds," *Ibid.*, vol. 34, p. 123. "On the Spectrum of Water," *Ibid.*, vol. 30, p. 480, and vol. 33, p. 274. "Investigations on the Spectrum of Magnesium," *Ibid.*, vol. 32. p. 189.

such actions seem to show that hydrogen is essentially connected with the production of this fluted spectrum just as nitrogen is with the cyanogen series." (*Ibid.*, vol. 34, pp. 126, 127).

The fact that carbonic oxide, which is one of the most stable binary compounds of carbon, forms a distinct spectrum of a character similar to that of the flame spectrum, tended to support the view that the flame spectrum might originate with acetylene. The similarity in the character of the magnesium-hydrogen spectrum to that of the hydrocarbon flame spectrum induced us to believe that they were due to similarly constituted compounds, and seeing we felt sure about the accuracy of the view which assigns the former spectrum to some compound of magnesium with hydrogen, we accepted the analogy in favour of the supposition that acetylene is the substance which produces the flame spectrum; or, at any rate, that acetylene is a necessary concomitant of the reaction taking place during its emission, and consequently might give rise to this peculiar spectrum.

Having examined this question in the way described, we adopted the view of Angström and Thalén as to the genesis of this spectrum in opposition to the views of Attfield, Morren, Watts, Lockyer, and others, who held that this the spectrum was really due to the vapour of carbon. The delicate character of the experiments which were required to discover the origin of the peculiar set of flutings in the more refrangible part of the spectrum of cyanogen made it apparent that, whatever view as to the origin of the hydrocarbon flame spectrum were adopted by different workers, it could not be regarded hitherto as experimentally proved which was the correct one. In referring to the theory that carbon vapour is the cause of the peculiar spectrum of cyanogen, we remarked: "Now, the evidence that carbon uncombined can take the state of vapour at the temperature of the electric arc is at present very imperfect. Carbon shows at such temperatures only incipient fusion, if so much as that, and that carbon uncombined should be vaporised at the far lower temperature of the flame of cyanogen is so incredible an hypothesis that it ought not to be accepted if the phenomena admit of any other probable explanation." (*Proc. Roy. Soc.*, vol. 30, p. 506).

With the object of being able to exhaust this question, a special study was subsequently made of the ultra-violet line spectrum of carbon, in order to ascertain whether any of its lines could be found in the spectra of the arc or flame. We have found that the ultra-violet lines of metallic substances have, as a rule, the greatest emissive power, and are often present when no trace of characteristic lines in the visible part of the spectrum can be detected. If carbon resembled the metals in this respect, then we might hope to find the ultra-violet lines belonging to its vapour, thus enabling us to detect the volatilisation of the substance at the relatively low temperatures of the arc and flame. The test experiments made on this hypothesis are recorded in the paper entitled "General Observations on the Spectrum of Carbon and its Compounds." It is there shown that some seven of the marked ultra-violet spark lines of carbon occur in the spectrum of the arc discharge, although one of the strongest lines, situated in the visible portion of the spectrum at wave-length 4266, could not be found. Further, it is proved that the strongest ultra-violet line of carbon does occur in the spectrum of the flame of cyanogen fed with oxygen. Thus it seems probable that the same kind of carbon molecule exists, at least in part, in the arc and flame, as is found to be produced by the most powerful electric sparks, taken between carbon poles or in carbon compounds.

Now the spark gives us the spectrum which is associated with the highest temperatures, and therefore it is assumed that this spectrum is that of the simplest kind of carbon vapour. If that be the case, we cannot avoid inferring that denser forms of carbon vapour must exist in arc and flame, emitting, like other complex bodies, a fluted, in contrast to a line, spectrum; or rather that the two distinct kinds of spectra may be superposed. Such considerations showed that a series of new experiments and observations must be made with the special object of reaching a definite conclusion regarding the origin of the flame spectrum, and the following paper contains a summary of the results of such an inquiry.

Vacuous Tubes.

We have heretofore laid little stress on observations of the spark in vacuous tubes on account of the great uncertainty as to the residual gases which may be left in them. The film of air and moisture adherent to the glass, the gases occluded in the electrodes, and minute quantities of hydrocarbons of high boiling-point introduced in sealing the glass, may easily form a sensible percentage of the residue in the exhausted tube, however pure the gas with which it was originally filled. The excessive difficulty of removing the last traces of moisture we learnt when making observations on the water spectrum, and the almost invariable presence of hydrogen in vacuous tubes is doubtless due in great measure to this cause. Wesendonck (*Proc. Roy. Soc.*, vol. 32, p. 380), has fully confirmed our observations as to this difficulty. By a method similar to that employed by him, we have, however, succeeded in so far drying tubes and the gases introduced into them that the hydrogen lines are not visible in the electric discharge. For this purpose the (Plücker) tube was sealed on one side to a tube filled for some six or eight inches of its length with phosphoric anhydride, through which the gas to be observed was passed, and on the other side to a similar tube full of phosphoric anhydride, which was in turn connected by fusion to the (Sprengel) pump. To dry the gas it is not enough to pass it through such a tube or even a much longer one full of phosphoric anhydride; it has to be left in contact with the anhydride for several hours, and to get the adhering film of moisture out of the tube it has to be heated after exhaustion while connected, as above described, with the drying tubes up to the point at which the glass begins to soften, and kept at near this temperature for some time. To get most of the gases out of the electrodes the tube must be exhausted and sparks passed through it for some time before it is finally filled with the gas to be observed. Even when these precautions have been observed, the lines of hydrogen can often be detected in tubes filled with gases which should contain no hydrogen. The general result of our observations on the spectra observed in tubes so prepared is that the channelled spectrum of the flame of hydrocarbons is not connected with the presence of hydrogen; it does not come and go according as hydrogen is or is not present along with carbon in the way that the channelled spectrum of cyanogen comes and goes according as nitrogen is present or absent. Our observations confirm those of Wesendonck on this point.

A tube filled with hydrogen containing a small percentage of cyanogen and exhausted, was found to give plainly the seven channellings in the blue and six channellings in the indigo characteristic of cyanogen, and the hydrogen lines of course strongly, but no more than a trace of the brightest green line of the spectrum of the flame of hydrocarbons. The use of a Leyden jar brought out no more. Continued sparking made no sensible difference, the cyanogen spectrum remained, the green line did not alter: and no other line of the spectrum of the hydrocarbon flame appeared. Tubes filled with carbonic oxide exhibit in general at different stages of exhaustion the following phenomena. When the exhaustion is commencing and the spark will just pass, the spectrum is usually that of the flame of hydrocarbons and nothing else. As the exhaustion proceeds the spectrum of carbonic oxide makes its appearance superposed on the former, and gradually increases in brilliance until it overpowers, and at last at a somewhat high degree of exhaustion, entirely supersedes the flame spectrum. This is when no jar is used. In the earlier stages of exhaustion the effect of the jar is to increase the relative brilliance

of the flame spectrum and diminish that of the carbonic oxide spectrum, and at the same time to bring out strongly the lines of oxygen and carbon ; at a certain stage of the exhaustion, when the flame spectrum is very weak without the jar, the effect of the jar is to bring it out again but without sensibly enfeebling the carbonic oxide spectrum, and without bringing out the carbon lines. At a still higher stage of exhaustion, when the carbonic oxide spectrum is alone seen without the jar, the flame spectrum is sometimes, not always, brought out by putting on the jar, though the carbon lines again show well. At this stage, at which the flame spectrum is not seen at all, the distance between the striæ in the wide part of the tube is considerable, and much metal is thrown off the electrodes, which are rapidly heated by the discharge. Some of these tubes were filled with carbonic oxide made by heating a mixture of potassium oxalate and lime contained in a prolongation of the tube containing the phosphoric anhydride, and thus were filled from a mixture of sodium oxalate and sulphuric acid heated in a flask sealed to a long tube, which had the middle part filled with quicklime and the two ends filled with phosphoric anhydride. After all the air was expelled and the flask had been sealed off, the quicklime was heated to absorb the carbonic acid. These tubes showed no trace of the cyanogen flutings at any stage of exhaustion, either to the eye or in photographs of the spectrum. Nevertheless, in the earlier stages of exhaustion, some of such tubes do show, when the jar is used, a group of three lines in the indigo which is seen in the flame of cyanogen, and has formerly been described by us as part of the spectrum of cyanogen. We must now, however, retract the opinion that this group is due to cyanogen. We have before noted (*Proc. Royal Society*, vol. 34, pp. 125, 127) that these three lines are seen under many different circumstances when the cyanogen flutings are absent, and as the flutings also are frequently seen without the three lines, it seems that the three lines belong to some other spectrum than the flutings, and as we have now found them where nitrogen has been carefully excluded, we are forced to attribute them either to carbon or some compound other than cyanogen. In one case a very little copper nitride was introduced into the one end of the drying tube, and after the whole had been filled with gas and the generating flask sealed off, the nitride was heated so as to mix a small quantity of nitrogen with the carbonic oxide. In the spectrum of this tube the cyanogen flutings were not visible to the eye, but the ultra-violet set between K and L came out plainly in the photographs.

No hydrogen line could be detected in it. This is remarkable, because Berthelot did not find that cyanogen is generated by electric sparks in a mixture of nitrogen and carbonic oxide unless hydrogen be also present. It would, however, be rash to assume that no trace of hydrogen was present because the lines of hydrogen were not visible in the spectrum, since we know by experience that the electric discharge does not always light up all that is in a tube. Mercury, for instance, must be present in all these tubes, but its lines do not usually show until the exhaustion is carried to a high degree. One tube was filled with nitrogen with which was mixed a small percentage of cyanogen obtained by heating a little mercury cyanide placed at one end of the drying tube. This tube gave well the channellings in the blue and indigo characteristic of cyanogen, but neither the hydrogen lines nor the spectrum of the hydrocarbon flame. The cyanogen seems to be scarcely at all decomposed by the spark when thus diluted, for the carbon lines were not brought out by the use of a jar, and the cyanogen spectrum remained after continued sparking. It is well to remark in passing that Berthelot found it exceedingly difficult to get acetylene from a mixture of cyanogen and hydrogen at atmospheric pressure. In order to make this experiment succeed, short and very powerful sparks must be continued for some hours. In a tube filled with carbonic oxide mixed with a little air imperfectly dried, when not too highly exhausted the carbonic oxide spectrum, that of the flame of hydrocarbons, and that of cyanogen, may all be seen at once superposed when no jar is used. With a jar and a tolerably high exhaustion the carbonic oxide spectrum, the hydrocarbon flame spectrum, and the carbon line spectrum, may all be seen at the same time. All the foregoing observations were made when the tubes were viewed end on and the image of the narrow part of the tube thrown on the slit by a lens. Tubes filled with carbon disulphide and carbon tetra-chloride at reduced pressures have been examined by us, but these compounds of carbon are very quickly decomposed by the spark, so that few observations can be made with one tube. If the exhaustion is not carried very far the spectrum of the hydrocarbon flame is seen both in carbon disulphide and in carbon tetra-chloride, when all the precautions above mentioned have been taken to remove moisture, and when no trace of the hydrogen spectrum is visible. At higher exhaustions the spectrum is a faint continuous one, and together with that of sulphur or chlorine as the one or other is present. The spark taken without condenser between electrodes near together in wide tubes filled with saturated vapour of carbon disulphide or carbon tetrachloride dried with phosphoric anhydride and deprived as completely as possible of air by pumping or boiling out, shows this spectrum of the flame of hydrocarbons brightly but in tubes filled with carbonic acid gas from ignited sodium carbonate and boric anhydride and sealed off at a high temperature, the spectrum is that of carbonic oxide together with that of oxygen.

Spectrum of the Spark in Compounds of Carbon at Higher Pressures.

In the spark taken between poles of purified graphite in hydrogen, the spectrum of hydrocarbon flames is seen, and it increases in brilliance as the pressure of the gas is increased up to ten atmospheres, and continues bright at still higher pressures so far as we have observed, that is, up to twenty atmospheres. The spark without condenser in carbonic oxide at atmospheric pressure, shows both the spectrum of carbonic oxide and that of the hydrocarbon flame; and as the pressure of the gas is increased, the former spectrum grows fainter, while the latter grows brighter, no jar being used. The line spectrum of carbon is also visible. At the higher pressures the flame spectrum predominates and is very strong. The observations were carried up to a pressure of twenty-two and a half atmospheres. On letting down the pressure, the same phenomena occur in the reverse order. All the parts of the flame spectrum, as seen in a Bunsen burner, are increased in intensity as the pressure is increased. The fact that the effects of high pressure are so similar to those produced by the use of a condenser at lower pressures, seems to point to high temperature as the cause of those effects. But against this, we have the fact that at reduced pressure we get in carbonic oxide, the carbonic oxide spectrum and the line spectra of carbon and oxygen simultaneously, without that of the hydrocarbon flame. As we cannot doubt that a very high temperature is required to give the line spectrum of carbon, we must suppose that reduced pressure is unfavourable to the stability of the molecular combination, whatever it be, which gives the hydrocarbon flame spectrum. Wesendonck has remarked (*loc. cit.*) that in carbonic acid at pressures too low for the flame spectrum to be developed without a jar, it is only in the narrow part of the tube that the use of a jar brings out that spectrum. It would appear, therefore, that the constraint, due to the confined space in which the discharge occurs, has the same effect, in regard to the stability of the combination producing the spectrum in question, as increase of pressure.

Cyanogen Flame Spectrum.

Our former observations "On the Flame Spectrum of Cyanogen Burning in Air" were made on cyanogen gas, prepared from well-dried mercury cyanide, which was

passed over phosphoric anhydride, and burnt from a platinum jet fused into the end of the tube. We observed what Plücker and Hittorf had noted, that the hydrocarbon bands were almost entirely absent; only the brightest green band was seen, and that faintly. When gaseous cyanogen is liquefied by the direct pressure of the gas, the researches of Gore (*Proc. Roy. Soc.*, vol. xx., p. 68) have shown that it is apt to be contaminated with a brownish, treacley liquid, which probably arises from the imperfectly purified or dried cyanide of mercury. In order to obtain pure cyanogen we have prepared quantities of liquid cyanogen, not by compression, but by passing the already cooled gas into tubes placed in a carbonic acid and ether bath. By this method of condensation any easily liquefiable substances are isolated, and any permanently gaseous substance escaped. The samples were sealed up in glass tubes into which different reagents were inserted. After such treatment the cyanogen was used for the production of the flame in dry air or oxygen. The liquid cyanogen was left in contact with phosphoric anhydride, Nordhausen sulphuric acid, and ordinary sulphuric acid. By means of a special arrangement of glass tubing surrounding the flame dry oxygen could be supplied, or oxygen made directly from fused chlorate of potash could, by means of a separate nozzle, be directed on to the flame, and thus perfectly dry and pure gases used for combustion. Liquid cyanogen which had remained in presence of the above reagents gave only the single green hydrocarbon line faintly in dry air, all the cyanogen violet sets being strong. When oxygen made directly from the chlorate of potash was directed on to the flame all the hydrocarbon flame sets appeared with marked brilliancy. The set of lines which we have formerly referred to as the three set of flutings of the cyanogen spectrum, show marked alteration of brilliancy with variations in the oxygen supply. Thus, liquid cyanogen purified by the action of the above reagents does yield the spectrum of hydrocarbons on combustion in pure oxygen. From the great precautions we have taken we feel sure that the amount of combined hydrogen in the form of water or other impurities in the combining substances must have been exceedingly small, and that the marked increase in the intensity of the flame spectrum when oxygen replaces air is essentially connected with the higher temperature of the flame, and is not directly related to the amount of hydrogen present. This being the case, it must be admitted that the flame spectrum requires a higher temperature for its production during the combustion of cyanogen than that which is sufficient to cause a powerful emission of the special spectra of the molecules of cyanogen. Now, the two compounds of carbon which give the highest temperature on combustion are cyanogen and acetylene. Both of these compounds decompose with evolution of heat, in fact they are explosive compounds, and the latent energy in the respective bodies is so great that if thrown into the separated constituents a temperature of between four and five thousand degrees would be reached. The flames of cyanogen and acetylene are peculiar in respect that the temperature of individual decomposing molecules is not dependent entirely on the temperature generated by the combustion which is a function of the tension of dissociation of the oxidised products, carbonic acid and water. We have no means of defining with any accuracy the temperature which the particles of such a body may reach. We know, however, that the mean temperature of the flames of carbonic oxide and hydrogen lies between two and three thousand degrees, and if this be added to that which can be reached by the substance independently, then we may safely infer that the temperature of individual molecules of carbon, nitrogen, and hydrogen in the respective flames of cyanogen and acetylene may reach a temperature of from six to seven thousand degrees.

A previous estimate of the temperature of the positive pole in the electric arc made by one of us was something like the same value.

The formation of acetylene in ordinary combustion seems to be the agent through which a very high local temperature is produced, and this is confirmed by the observations of Gony on the occurrence of lines of the metals in the green cone of the Bunsen burner, which are generally only visible in spark spectra; on this view acetylene is a necessary agent in the production of the flame spectrum during combustion. The fact that the flame spectrum is often invisible when the arc is taken in a magnesia crucible, although the cyanogen spectrum is strong, but may be made to appear by introducing a cool gas or moisture, must be accounted for by an increased resistance in the arc producing temporarily a higher mean temperature. The experiments in course of execution, where the arc will be subject to a sudden increase of pressure, will, we trust, solve this difficulty.

Electric Discharge between Graphite Poles and different Gases.

When pure graphite is employed, instead of the ordinary carbon poles, and the arc discharge is taken in different gases, in the same way as was described in the first paper, "On the Spectra of the Carbon Compounds," we have noticed some slight differences which are worthy of record. In carbonic acid gas fine channellings are seen covering the whole extent of the spectrum from the low red as far as the blue set of the flame spectrum, the flutings of the one group being observable as far as the next group. The triple set of the cyanogen flame spectrum remained very strong when all the cyanogen groups in the violet had disappeared. When the carbonic acid is displaced by hydrogen the hydrogen lines appear, the hydrocarbon and triple sets remaining bright; but in this gas the flame group at 431 is particularly well marked, and the carbon line at 4266 keeps flashing in occasionally. Thus we have in the same field of view the hydrocarbon series, the hydrogen lines, and one of the strongest lines of carbon. The De Meritens intermittent arc discharge was employed in these experiments, and it is curious to note that hydrogen, instead of favouring the passage of the arc between carbon poles, really introduces some peculiar resistance, probably owing to the great reduction of temperature by the large mass of gas surrounding the arc, or because of the formation of acetylene. The arc is much shorter than in air, but the temperature seems to be correspondingly increased, as we may infer from the fact that the hydrogen and carbon lines are now very marked. The Siemens arc in air does not show the carbon line at 4266, although we have proved that some of the chief ultra-violet lines occur in this discharge. The arc taken in carbonic oxide shows the triple group along with the usual sets of the flame spectrum, without any trace of the carbonic oxide spectrum being visible. The occurrence of the triple set of lines, in the absence of other groups much more characteristic of cyanogen, makes us doubt whether they have anything really to do with nitrogen. We are inclined to think that their previous appearance when the arc was taken in glycerine containing nitro-benzole was really due to some indirect effect, and ought not to be taken as proof of the formation of cyanogen in the absence of other characteristic groups under such circumstances.

Further evidence of the high temperature of the cyanogen flame is afforded by the occurrence in the spectrum of that flame, when fed with oxygen, of a series of flutings in the ultra-violet, which appear to be due to nitrogen. The series consists of four, or perhaps more, sets, each set consisting of a double series of lines overlapping one another. The lines increase in their distance apart on the more refrangible side, otherwise the flutings have a general resemblance to the B group of the solar spectrum.

The four sets commence approximately at about the wave-lengths 2718, 2588, 2479, 2373 respectively. They are frequently present in the spectrum of the arc taken in a magnesia crucible, and show strongly in that of the spark taken without a condenser either in air or nitrogen. As they appear in the spectrum of the spark in nitrogen, whether the electrodes be aluminium or magnesium, and

do not appear when the spark is taken in hydrogen or in carbonic acid gas, they are in all probability due to nitrogen. When a large condenser is used they disappear.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING NOVEMBER 30TH, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

December 1st, 1882.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the month of November, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 182 samples, three were recorded as "very slightly turbid." The remaining 179 samples were found to be bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from Nov. 1st to Nov. 30th inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, two were recorded as "very slightly turbid," the remaining 24 samples being well filtered, clear, and bright.

Of the 26 samples from the mains of the Grand Junction Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, the whole, excepting one which was recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

It will be seen that, throughout the month of November, the condition of the metropolitan water, in respect to its degree of freedom from colour and turbidity, was considerably in advance of that to which we called attention as being noticeable in some instances, during the latter part of the preceding month. As usual, indeed, in the winter season, when despite the excellent state of aëration of the water, the processes of oxidation take place more slowly, the proportion of organic matter was somewhat high, and corresponded very closely with that found to prevail a month later in the previous year. So far, however, as the ratio of organic carbon to organic nitrogen can be depended on as a criterion, this organic matter would appear to have mainly a vegetable origin, a conclusion that is further borne out by other considerations.

We have the honour to remain, Sir,
Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ON THE DETERMINATION OF THE FLASHING-POINT OF PETROLEUM.

By JOHN T. STODDARD.

IF the best method known for determining boiling-points gave trustworthy results only when size and shape of the retort, quantity of liquid, and distance from surface of liquid to the vapour delivery tube conformed to certain rigid specifications—the results varying many degrees with a change in any one of these conditions—we should feel not only that a method demanding such precision in apparatus and manipulation left much to be desired in these particulars, but also that the determinations obtained under such arbitrary conditions could be themselves but arbitrary and undeserving the name of true boiling-points.

And yet until quite recently the best apparatus devised for finding the flashing-point of petroleum presented similar and even more numerous disadvantages.* The flashing-point as given by these instruments depends upon the size and shape of the oil holder, the quantity of oil, the means of ignition, and distance of the flame or spark from the surface of the oil, as well as upon a number of minor conditions. Agreement in the determinations of a given oil by means of a given tester demands skilful and painstaking manipulation; and agreement of different testers can apparently be secured only by selecting one as arbitrary standard and adopting conditions in the others which shall give corresponding results.

The attempt has evidently been made to simulate in these testers the conditions presented in the oil reservoir of a quietly-burning lamp. But these conditions vary in every lamp, and in the same lamp at different times; moreover, it is not only in lamps as properly used and the cans and storage tanks of kerosene that explosions occur. Safety is insured only when we know that under no *possible* conditions, at the temperature to which it is liable to be exposed, can the oil evolve inflammable vapours. We should be able to determine the *minimum* flashing-point, and the method should be as independent of external conditions as that employed for finding the boiling-point.

The first suggestion of a principle by which this could be accomplished is due to V. Meyer.† It is saturation of air with vapour of the oil. Recognising the promise of this principle, I have studied the methods proposed for its application, paying particular attention to that recently devised by Liebermann.‡

In the method proposed by Meyer, as well as in the elaborate and clever apparatus of Haass,§ the saturation of air with vapour is effected by shaking the oil in a closed vessel. Both are dependent for reliable results upon the interval of time allowed between the shaking and the testing. The shaking repeated from degree to degree is an unpleasant feature of these methods. The apparatus

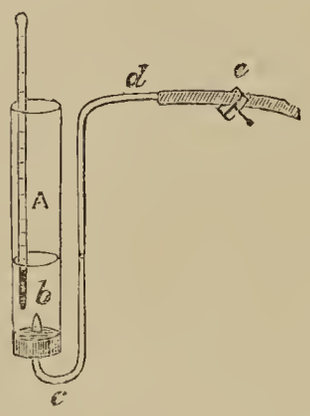
* Cf. Engler and Haass, *Zeit. Anal. Chem.*, 20, 1.
† Wagner's *Jahresb.*, 1879, 1175, and *Zeit. Anal. Chem.*, 20, 28.
‡ *Zeit. Anal. Chem.*, 21, 321.
§ *Ibid.*, 20, 29.

of Haass cannot be made in the laboratory, and is expensive, costing, complete, 60 marks.

Liebermann's apparatus and method present none of these disadvantages. The air is saturated with vapour by being forced through the oil by pressure of a rubber bulb from degree to degree, while at the same instant a small flame is brought to the mouth of the oil holder. The apparatus has the recommendation of simplicity of construction and manipulation, and gives, as I have found, concordant results. Considerable care is, however, necessary to prevent spurting and regurgitation of the oil, as the air current is suddenly started and interrupted. A continuous air current, Liebermann says, although simplifying the manipulation, raises the flashing-point by preventing the accumulation of vapour enough for an explosion.

This statement I am unable to confirm, finding, on the contrary, that a continuous current of air, *if only rapid enough*, gives results identical with those of the intermittent method.

As result of my experiments I have adopted a modification of Liebermann's apparatus and method. The apparatus is shown in the cut. The cylinder is 2 to 3 c.m.



in diameter and 10 to 12 c.m. long. Just within the wooden cork the small tube contracts to a fine orifice; at *d* it is connected by rubber tubing with a source of compressed air—small water blast, hand bellows, or gasholder—the flow of which can be controlled by the pinch-cock, *e*. Its use is as simple as its construction; A is about one-third filled with oil, and secured in a clamp at *d*, so that it plunges in a water-bath to the level of the oil.* Air is now allowed to flow through *d c b*, and *e* adjusted so that about 0.5 c.m. foam is maintained on the surface of the oil. From degree to degree the test is made by bringing a small blowpipe flame or a match for an instant to the mouth of A. At the flashing-point the vapours ignite and the bluish flame runs down to the surface of the oil.

It is noteworthy that a *slow* continuous current of air gives a considerably higher flashing-point. The rapid current is effective by bringing the vapour to the mouth of the tube and diluting it sufficiently to form an explosive mixture.

The results are very satisfactory, and the apparatus so simple that it can be made in ten minutes in any laboratory. Further important advantages are the ease of manipulation, and readiness with which it can be thoroughly cleaned.

In all the apparatus suggested by Meyer's principle the determinations are largely independent of size or shape of oil holder, quantity of oil, means of ignition, distance of spark or flame from surface of oil, and rapidity of heating, and in the form above described the determination of the flashing-point becomes as easy and trustworthy an operation as that of determining the boiling-point, while the results have a significance wholly wanting to those obtained by the older methods.

Determinations of Flashing-Points.

1. Comparison of Liebermann's method with the above described modification:—

	By L.'s Method.			By the Modification.		
Petroleum A.	41	40·1	40·1	40	40	39·9
	40·5	40·5	40	40	40·1	40
Petroleum B.		29			29	29

2. Influence of varying velocity of air current:—

Petroleum A.	Very slow	43
	Slow	41
	Fast enough to form 0·5 c.m. foam	40
	Very much faster	39·8, 39·5, 39·5

3. Influence of height of oil in holder:—

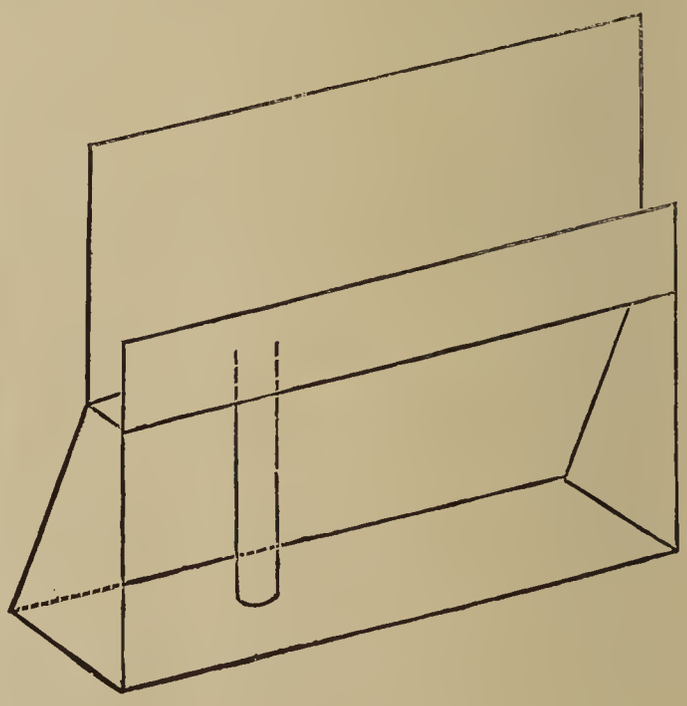
Petroleum C.	Holder ¼ full,	38·5
	,, ⅓ ,,	38·3
	,, ⅔ ,,	37·8

All determinations are in Centigrade degrees.—*American Chemical Journal.*

NOTE ON A TUBE-STAND FOR NESSLERISING.

By P. T. AUSTEN and F. A. WILBUR.

A short time since, while making some determinations by Wanklyn's method of water analysis, we were much troubled by cross lights, which made it impossible to obtain satisfactory readings. After several attempts we hit upon the following form of stand, which has given the most excellent results, and which has the advantage of being easily and cheaply made. The following figure represents the apparatus.



The tall shield consists of a piece of quarter-inch board 6 inches wide, tacked to the cross-piece. The low shield is 3 inches wide. The stand and shield are painted black. Over the bottom piece a strip of ordinary window-glass, painted white on the under side, is laid. Instead of painting, which of course must be done with a pigment

* If plunged deeper than this, the sides of A above the level of the oil may become overheated, and, as they are constantly moistened by the foam, the flashing-point is, in consequence, lowered. On this account I prefer a water- to an air-bath.

not affected by the laboratory fumes, a piece of white paper may be inserted between the glass and the wood, or the wood itself may be given a coat of white paint. The latter method is in some respects the most advisable, for there is then no danger of breaking the tubes by dropping on the glass. Another advantage is that the wood may receive slight hollows so as to steady the tubes and hold them perpendicular. The whole stand can also be easily made from sheet-iron.

The tubes are ordinary 7-inch test-tubes holding about 60 c.c. They project about an inch and a half above the level of the perforated cross-piece. When filled the liquid is about level with the surface of the cross-piece. We find it convenient to mark the number of tenths of ammonia represented by the standard tube on the upright shield behind it. The standard tubes are placed in every other hole, the intermediate holes being used for the tubes containing the distillates. We are in the habit of using two stands, each containing twenty holes and ten standard tubes, the two running from 0·01 to 0·20. The tube containing the distillate, after being treated with the Nessler solution, is placed between the two standard tubes to the colour of which it approximates the most nearly, and the reading then made.

The stand is placed with the tall upright toward the light. On looking down into the tube, the colour appears with remarkable clearness and brilliancy, thus rendering the reading very accurate and satisfactory.—*American Chemical Journal.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 21, 1882.

Dr. Gilbert, F.R.S., President, in the Chair.

The following certificates were read for the first time :—H. C. Bond, J. T. Donald, A. H. Jackson, H. Jones, J. E. Johnson.

The Secretary then read a paper "*On the Condensation Products of Œnanthol* (*Part II.*)," by W. H. Perkin, jun. When œnanthol is acted upon by nascent hydrogen it is well known that heptylic alcohol is produced, but, in addition, other products of higher boiling-points are formed in some quantity, and the author has accordingly investigated them. The œnanthol was first dissolved in acetic acid, and a sodium amalgam containing 2 p. ct. of sodium added. When the action was finished water was added, and the oil which separated dried and distilled at 300 m.m. pressure. The portion which distilled under 200° consisted chiefly of heptyl alcohol and œnanthol: the higher fraction contained the aldehyd $C_{14}H_{26}O$, and the alcohol $C_{14}H_{28}O$. The œnanthol was next dissolved in a large excess of ether, floated on water, and treated with sodium. The aqueous solution contained some heptylic acid. The ethereal solution was distilled at 150° to 200°, when œnanthol and heptylic alcohol came over. The temperature then rose: between 250° and 310° most of the remainder came over. This distillate was re-fractionated, and an aldehyd obtained in crystalline plates melting at 29·5°, distilling between 266° to 268°, and having the composition $C_{14}H_{28}O$. A second substance was also separated as an oil solidifying at −10°, boiling about 320°, reducing ammoniacal silver nitrate, and having the formula $C_{21}H_{40}O$. The author next studies the oxidation of the aldehyd $C_{14}H_{28}O$. The chief products (with chromic acid or silver oxide) were heptylic and hexylic acids, but with silver oxide an acid boiling at 300° to 310° was obtained in small quantity, with the composition $C_{14}H_{28}O_2$. By acting on the aldehyd $C_{14}H_{28}O$ dissolved in acetic acid, first with zinc slightly coated with copper and subsequently with sodium amalgam, an oil was obtained boiling at 270° to 275°, which analysis proved to be the alcohol $C_{14}H_{30}O$ already obtained in Part I. The author then discusses the constitution of these bodies. The solid aldehyd and the acid obtained from it are isomeric with myristic aldehyd and myristic acid; but myristic aldehyd fuses at 53·8°, the new substance at 29·5°. From the oxidation products the author considers that the acid must be heptyl-pentyl acetic acid—

$$CH_3(CH_2)_5CH_2$$
$$|$$
$$CH_3(CH_2)_4CH-COOH$$

The next part of the paper refers to the polymerisation of œnanthol. The solid polymer $(C_7H_{14}O)n$, which has been previously obtained, was distilled, and from various experiments the author concludes that $n=4$, and the body has the composition $C_{28}H_{56}O_4$.

Dr. Armstrong congratulated the author on having completed an arduous piece of work, which was besides very interesting, as it gave us a synthetical method for preparing the normal paraffins.

Prof. W. Foster then read a paper "*On the Behaviour of the Nitrogen of Coal during Destructive Distillation, with some observations on the Estimation of Nitrogen in Coal and Coke.*" It is usually stated in text-books that coal contains about 2 per cent of nitrogen which, when the coal is heated in close vessels, usually comes off as ammonia. The author, however, finds that only a small fraction of the total nitrogen comes off as ammonia. Durham coal was employed, which contained 1·73 per cent of nitrogen, and left 74·46 per cent of coke. A weighed quantity of the coal was placed in a combustion tube sealed at one end, and the issuing gas was washed free from ammonia by hydrochloric acid. The gas thus freed from ammonia was passed through a second heated combustion-tube containing slaked lime: the additional ammonia thus obtained came from the decomposition of cyanogen in the gas. Taking the total nitrogen in the coal as 100, only 14·5 per cent is evolved as ammonia, 1·56 per cent as cyanogen, 35·26 is present in the coal-gas as nitrogen, whilst 48·68 per cent remains behind in the coke.

Dr. Percy Frankland said that Dr. Hoffmann in his report in connection with the Exhibition of 1862, stated that only one-third of the nitrogen was evolved as ammonia, two-thirds remaining behind in the coke, and as far as he knew nothing had been done with the subject until Mr. Foster had taken it up. He had made some combustions of the coal used by that gentleman, using the apparatus employed in the combustion of a water residue. About 0·024 grm. of coal was taken: great difficulty was experienced in getting all the nitrogen off.

Dr. Armstrong suggested that as regards the results obtained everything would depend on the temperature, and it would be interesting to know how the quality of the coal affected the results.

Prof. Foster said that in his experiments he had endeavoured to imitate as far as possible the usual process employed in the manufacture of coal-gas. He hoped to be able to make some experiments shortly, in which he would employ a Siemen's regenerating furnace, and so have the temperature under control.

The Secretary then read a paper "*On the Absorption of Weak Reagents by Cotton, Silk, and Wool,*" by E. J. Mills and J. Takamine. The object of the authors was the quantitative measurement of such absorption. 250 c.c. of the weak reagent (dilute sulphuric acid, dilute hydrochloric acid, or dilute caustic soda) were placed in a bottle and kept at a constant temperature; in the bottle was placed also a known weight of the tissue (usually 3 grms.). After a week or more the tissue was removed, and a known volume of the remaining liquid titrated. The diminution of strength gives, so the authors state, the amount of absorption. In the second part of the paper the authors have determined in a similar way the ratio of absorption

from mixtures of the acids. The paper contains numerous tables giving the results calculated to five places of decimals, and the mean probable errors. The paper concludes as follows:—There is thus a very intimate relation between silk and cotton—a relation which, whatever it may be in part, is shown by these changes to be, to a great extent, of a strictly chemical nature. We have, in conclusion, to express the hope that an investigation, while bearing on the one hand on questions of great technical importance, may not be without its value in the profounder future study of cotton, silk, and wool—three bodies of definite chemical composition, but whose intimate constitution still remains obscure.

Mr. Cross said the subject was extremely interesting, as bearing on the constitution of fibre. He had made experiments of a similar kind, but had found it very difficult to separate the various factors involved. He did not think that it was correct to assume that the loss in strength of the solution was an accurate measure of the absorption by the fibre, because the fibre might absorb a solution of a different density to that left outside the fibre. He had investigated the subject, and could not satisfy himself that the fibre did not take up a solution of different density to that left outside the fibre. In some experiments with aniline dyes he found that asbestos gave results similar to those obtained with some of the fibres used. The effect of the constituents of the ash seemed to have been neglected by the authors.

Dr. Schunck said it was important to determine the absorption by different samples of the same fibre.

Mr. W. A. Shenstone then read a paper entitled "*The Alkaloids of Nux vomica. No. 2. On Brucine.*" The author has made many experiments as to the limited oxidation of brucine and strychnine, but at present without any definite results. Strecker, Liebig, and others, state that brucine, when treated with dilute nitric acid, yields, amongst other products, either methyl or ethyl nitrate or nitrite. As the formula of brucine suggested that it might be a dimethoxyl derivative of strychnine, the author proceeded to investigate the question. He finds that 1 grm. brucine, when heated with fifteen times its weight of hydrochloric acid for fourteen hours to 135°, then for thirteen hours to 145°, then seven hours to 150°, and finally seven hours to 160°, evolved 90·2 c.c. of a gas, which analysis proved to be methyl-chloride. 1 grm. of dimethoxy-strychnine should give 113 c.c. It is probable, therefore, that brucine is strychnine in which two atoms of hydrogen are replaced by two methoxyl groups, and that it has the formula—

$$C_{21}H_{20}(CH_3O)_2N_2O_2.$$

The contents of the sealed tubes after the escape of the gas were black and usually tarry: an examination led to no satisfactory results. The author also studied the action of hydriodic acid upon brucine, but the substances formed are unstable. The author intends to examine strychnine, and thus endeavour to make out the relations of the *Nux vomica* alkaloids, since the removal of the methoxyl groups from brucine seems to give rise to bodies of such unstable character.

Dr. W. H. Perkin then read a "*Preliminary Note on some Diazo-Derivatives of Nitro-benzyl-cyanide.*" When an alcoholic solution of nitro-benzyl-cyanide is mixed with an alcoholic solution of caustic potash, an intense crimson-red colour is produced, which gradually changes through a brownish purple to a greenish blue colour. It appeared, therefore, that some definite though unstable compound was produced, and it seemed probable that it might yield a derivative with the diazo-bodies. The alcoholic solutions of the above-mentioned bodies were mixed, and immediately afterwards an aqueous solution of diazo-benzene chloride was added until the red colour disappeared. The product was further diluted and filtered; the precipitate washed, purified by recrystallisation, and finally orange-yellow needles obtained, melting at from 200° to 202°, having the formula $C_{14}H_{10}N_4O_2$. The constitution of this body has not yet been established, but it appears to be analogous to the phenyl-anilo-acetic nitryl obtained recently by Tiemann.

The Secretary then read a paper, "*Researches on the Induline Group*," by O. N. Witt and E. G. P. Thomas. The term induline is applied in commerce to a series of violet and blue dyes, distinguished by great fastness to light and atmospheric influences. Scientifically the term may be applied to all coloured compounds formed by the action of amido-azo-compounds on the hydrochlorides of aromatic amines with elimination of ammonia. In the present paper the authors give an account of their researches on the formation of amido-azo-benzene and its action on aromatic hydrochlorides. It has long been known that amido-azo-benzene, when heated with aniline hydrochloride or nitrate, produces a dark blue colouration. The authors find that invariably several colouring-matters, differing from each other both in composition and properties, are formed, and that the nature as well as the quantities of the products depend largely on the temperature at which the reaction takes place, and the manner in which it is conducted. In this paper the authors describe these various compounds and their preparation, and promise in a future communication to explain the reaction and the constitution of the products.

The Society then adjourned till January 18, 1883.

THE METEOROLOGICAL SOCIETY.

The usual monthly meeting of this Society was held on Wednesday evening, the 20th inst., at the Institution of Civil Engineers, Mr. J. K. Laughton, M.A., F.R.A.S., President, in the Chair.

Four new Fellows were elected, and Capt. J. de Brito Capello and Mr. W. Ferrel, M.A., were elected Honorary Members.

The following papers were read:—

"*Popular Weather Prognostics*," by the Hon. R. Abercromby, F.M.S., and Mr. W. Marriott, F.M.S. The authors explain over one hundred prognostics by showing that they make their appearance in definite positions relative to the areas of high and low atmospheric pressure shown in synoptic charts. The method adopted not only explains many which have not hitherto been accounted for, but enables the failure, as well as the success, of any prognostic to be traced by following the history of the weather of the day on a synoptic chart. The forms discussed are:—Cyclones, anticyclones, wedge-shaped and straight isobars. The weather in the last two is now described for the first time. They also point out (1) that prognostics will never be superseded for use at sea, and other solitary situations; and (2) that prognostics can be usefully combined with charts in synoptic forecasting, especially in certain classes of showers and thunderstorms which do not affect the reading of the barometer.

"*Report on the Phenological Observations for the Year* 1882," by the Rev. T. A. Preston, M.A., F.M.S. The most important feature of the Phenological year was the mild winter. The effect of this upon vegetation was decidedly favourable, and had it not been for the gales—especially that of April 28th,—the foliage would have been luxuriant, and therefore free from insect attacks, but the contrary effect has been produced on insect life, for the scarcity of insects, especially butterflies and moths, has been the general remark of entomologists.

Mr. J. S. Dyason, F.R.G.S., exhibited a series of typical clouds in mono-chrome, and also a series of sketches of clouds in colour, made in June, July, and August, 1882.

Displacements and Deformations of Electrical Sparks by Electrostatic Action.—M. Aug. Righi describes a method by which the spark may be displaced and deformed like a flexible body if positively electrified.—*Comptes Rendus.*

CORRESPONDENCE.

USEFUL APPLICATIONS OF ELECTRICITY.

To the Editor of the Chemical News.

Sir,—Enclosed with this communication I send a small instrument similar to one which has been singularly useful in one of our Colonies, by assisting in the discovery of an ore of copper in a locality where no such substance had been suspected to exist. In the present state of the negociations with respect to this ore I am not in a position to give more than a general outline of facts, which are as follows :—

About twelve years ago a Colonial seller put up a mill upon a stream of water that ran through his estate. This mill was for the double purpose of grinding corn and sawing wood, and was set in motion by an under-shot water-wheel, the ironwork of which seemed to decay more rapidly than usual; therefore another wheel was made with galvanised iron nails and screws, but this produced no visible change in the destruction; and nearly four years ago the subject was brought under my notice by a friend of mine, who then had just received a letter, in which the matter was casually mentioned. I immediately made a small instrument, such as I now send you, and giving this to my friend, I begged of him to ask the Colonist as a favour to suspend the instrument by a piece of catgut for three months in the current of water, and after that time to return it to me by letter. More than twelve months afterwards I received the instrument back, with an amount of information that would have prevented me from thinking of the instrument if this had been given in the first instance; for the stream was well furnished with fish, the Colonist's horses, oxen, and sheep all drank the water, and an aboriginal native man who lived in the mill also drank the water, and no injury followed. On looking at the instrument, however, I saw that the iron was corroded, and the platinum wire had become black, so I cut off the platinum wire, and having bent it to fit the concavity of a watch-glass, I caused a drop of nitric acid to run from one end of it to the other, during which course the acid gave off red fumes and became of a fine green colour. To confirm the opinion created by this effect, I added a few drops of a solution of the acetate of potash, and then put a drop of the mixture upon a piece of polished iron, which immediately became red from a coating of copper, and the subsequent use of ferrocyanide of potassium and liquor ammoniæ added to the evidence. I consequently wrote to say what I had found, and suggested that the banks of the river higher up might be profitably searched to see whether any small stream joined it, and I sent out six instruments with which to test any such stream if found. The result has been most satisfactory: such a stream was found about 5 miles higher up, and the water from it, in the language of the Colonist, "there and then turned the white wire red, as you looked at it," and this stream was traced to a black bog at the foot of a low hill, from the side of which the water oozed out in many places, and at a few inches below its surface the hill was found to be rock, and in the rock several veins of yellow metal were seen from quarter of an inch to 3 inches in thickness. Samples of both were sent to me, and the yellow metal proved to be copper pyrites containing about 30 per cent of copper, and the rock was mountain limestone, which information I communicated to the Colonist, and in his reply, just now received, he tells me that he is attempting to purchase the hill, without explaining his object to anyone.

In my opinion the most remarkable, and also the most important part of this discovery, is to be found in the fact that a water containing copper can be drank with impunity. The relative amount is no doubt infinitesimally small, and far beyond the reach of ordinary reagents, but its presence in the water is indisputable, and we may perhaps usefully ask ourselves whether our prevailing fear of metallic contamination rests upon a rational foundation. Dr. Paris, in his "Pharmacologia," says—"It is a curious fact that previous to the introduction of copper works in Cornwall agues were very frequent, but since that period the disease is extremely rare, and I have heard it remarked by the men in the works, that the smoke kills all fevers;" and the Dr. then asks, "Is this owing to the arsenical fumes?"

I will now describe the mode of constructing the little instrument above-mentioned. It is formed of two kinds of wire, iron and platinum. The iron wire is of such a size that one inch of it weighs seven grains, and of the platinum wire four inches weigh three grains. A piece of each of these wires, three inches in length, is to be cut off, and one end of the iron wire is to be flattened by the blow of a hammer, after which the two pieces of wire are to be bound together, so that one end of the platinum wire rests upon and touches the flattened surface of the iron wire, when the whole being laid upon a piece of charcoal, a morsel of silver not larger than a pin's-head must be put upon the point where the two wires touch each other, and this being then lightly dusted over with powdered borax, a smart application of the blowpipe flame melts the silver and unites the wires, by which the instrument becomes at once complete, and when used requires only to have the two wires separated into the form of the letter V.

The advantages of this instrument are soon told. It costs less than twopence; it weighs about 25 grains, and can be sent by post to any part of the world, where it can be set in action by an uneducated person, and in due time returned back to this country and examined scientifically. When suspended by catgut or silk for many months in a current of water it necessarily comes in contact with several millions of gallons of that water from which by electrical agency it separates the metallic matter and stores it upon the platinum wire for future examination, so that no ordinary reagent can be compared with it in point of delicacy. By its means I have lately detected lead in the water of a hill-stream derived from a granitic source, and reputed to be singularly pure, and I have now, through the kindness of friends, several of these instruments at work in various parts of Great Britain; nor will it greatly surprise me if the much-praised hill-stream water proves to be more metalliferous than common river-water; for we must remember that river-mud ferments, and in so doing evolves sulphuretted hydrogen and hydrosulphate of ammonia, by which the metallic contaminations of the river-water are precipitated and removed, so that here, as in many other instances, we discover an example of that far-seeing Providence which has made impurity itself a means of purification. But until we know much more than we know at present of the effect of minute quantities of metallic matters upon the human constitution we had better draw no conclusions, for it may happen that the metallic impurities of hill-water (supposing them to exist) are precisely the cause of the salubrity of such water.—I am, &c.,

Lewis Thompson.

Action of Phosphorus Trichloride and Tribromide upon Gaseous Hydrogen Phosphide.—P. de Wilde.—The author finds on thermo-chemical data, that the reaction given by H. Rose is impossible, unless we assume a disengagement of at least 21·4 cals. on the formation of two atoms of amorphous phosphorus. M. de Wilde finds that it is merely the vapours of liquid hydrogen phosphide contained in the spontaneously inflammable gas which react with phosphorus trichloride. The solid yellow body which Rose observed, and which he named yellow phosphorus, is a solid hydrogen phosphide.—*Cosmos Les Mondes*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Seiences. Vol. xcv., No. 22, November 27, 1882.

Reply to the Objections of M. Decharmes on my Conception of the Nature of Electricity. Proofs of the Validity of the Hypothesis serving as the Base of this Conception.—A. Ledieu.—This discussion does not admit of useful abridgment.

The General Law of the Congelation of Solvents.—F. M. Raoult.—Every substance when dissolving in a definite liquid compound, capable of solidifying, lowers its congelation-point. In all liquids the molecular lowerings of congelation due to different compounds approximate to two values, invariable for each liquid, one of which is double the other. The greater value appears most frequently, and constitutes the normal molecular lowering. The less corresponds to the case where the molecules of the dissolved body are connected two by two. The normal molecular lowering of solidification varies with the nature of the solvent. A molecule of any compound when dissolving in 100 mols. of any liquid whatever of a different nature lowers the solidification-point of this liquid by a quantity almost constant and close upon 0·62°.

Chemical Studies upon Maize at Different Stages of Vegetation.—H. Leplay.—The author treats of the formation and accumulation of crystalline sugars, reducing sugars, and starch in different parts of the plant.

Electric Motors.—Marcel Deprez.—Not suitable for abstraction.

Reform of certain Analytical Procedures used in the Laboratories of Agricultural Stations and in the Observatories of Chemical Meteorology. Memoir 4.—Volumetric Determination of the Alkaline Earthy Carbonates contained in Waters.—Aug. Houzeau.—The method depends upon the following facts:—If, to two separate solutions of calcium bicarbonate and sulphate containing the same proportion of calcium, there is added a similar quantity of a weak solution of oxalic acid, we observe a production of calcium oxalate, which appears much more rapidly in the first solution than in the second. It appeared to the author possible to utilise this difference observed in the speed of the reactions so as to determine volumetrically in flowing waters calcium and magnesium bicarbonates, whether associated or not with calcium sulphate. The method of operation differs sensibly according as the water contains merely bicarbonates, or sulphate along with the former.

First Case.—Bicarbonated Waters; Method of Operating. A.—Into 100 c.c. of water coloured with 1 c.c. of an alcoholic solution of cochineal upon which free carbonic acid has no action, we pour drop by drop a standard solution of oxalic acid (1 c.c. = 28 m.g. $6C_2O_3,3HO$) until the appearance, easily recognised, of the stable yellow tint. The volume of oxalic acid employed shows the weight of the carbonic acid combined with bases in the state of neutral carbonates. The calcium oxalate, collected upon a filter, is determined volumetrically by means of standard permanganate (1 litre = 1·6 grm. permanganate). From the weight of the oxalic acid found we deduce that of the carbonic acid equivalent to it, and consequently that of the lime. On deducting from the total weight of the carbonic acid found by the standard oxalic acid that of the carbonic acid answering to the calcium oxalate, the difference is the carbonic acid present in magnesium carbonate. The results are exact for waters which do not contain alkaline carbonates.

B. The procedure may be simplified if approximate results are considered sufficient. By making use of a burette with a capillary orifice the standard acid may be slowly added to the decilitre of water coloured with cochineal, stopping as soon as the calcium oxalate begins to appear. After settling for three minutes we filter, and the liquid passes through clear if the paper is of good quality. The standard acid is then again added until the appearance of a new turbidity, if there still remains calcium bicarbonate. In a word, the volume of the standard oxalic acid employed for the precipitation of the lime shows the weight of the calcium carbonate; that which has been further used for producing the final yellow colouration gives the weight of the magnesium carbonate. In less than fifteen minutes we may find the respective proportions of calcium and magnesium carbonate in a water with approximate accuracy. The determination of the total combined carbonic acid remains exact, but its distribution among the bases leaves something to be desired.

Second Case—Bicarbonated and Sulphatic Waters.—When these waters do not contain magnesium carbonate the direct titration with oxalic acid gives in an exact manner the weight of the neutral calcium carbonate. The result is different when there is present magnesium carbonate, for the soluble oxalate of this base reacts upon the calcium sulphate. It is first necessary to eliminate the calcium sulphate before proceeding to add the oxalic acid. This elimination is easily effected if to the decilitre of water to be assayed we add a suitable volume of alcohol saturated with carbonic acid which precipitates the sulphate without touching the bicarbonates, whilst ordinary alcohol precipitates an important fraction of these bicarbonates. After standing the alcoholic liquid is decanted or filtered. We take then 100 c.c., which we mix with an equal volume of distilled water, and proceed to the volumetric assay as indicated above. The titrations with oxalic acid are easily effected without stirring in flat bottomed half-litre flasks, to which a rotatory movement is given, or, better, in conical glasses of the same size, of Bohemian glass.

December 4, 1882.

Memoir on the Vision of Material Colours in Rotatory Movement, and on the Respective Speeds of Circles of which one Diametral Half is Coloured and the other Colourless.—M. E. Chevreul.—A treatise extending to 24 pages and incapable of useful abstraction.

Presence of Nitric Acid and Ammonia in Water and Snow Collected in the Glaciers of the Alps.—M. Boussingault.—It appears that at great heights, say of 3000 m. and upwards, nitric acid is always absent, and ammonia when present is found in small proportions.

Chemical Studies on Maize at Different Epochs of its Vegetation.—M. H. Leplay.—Continued from the last number.

The Currents Produced by Nitrates in Igneous Fusion in Contact with Incandescent Carbon.—M. Brard.—The author setting out from the principle described in his paper of Nov. 13, has constructed what he calls a "briquette battery," by means of which he has succeeded in decomposing water.

Method of Transforming Tricalcic Phosphate into the Chlorinised Compounds of Phosphorus.—M. J. Riban.—By passing simultaneously chlorine and carbon monoxide over a mixture of carbon and tricalcic phosphate, the latter is entirely converted at a low temperature—that of the oil-bath—into phosphorus oxychloride with formation of calcium chloride and carbon dioxide.

New Hydrocarbide.—M. E. Louise.—The author has obtained benzyl-mesitylene by causing benzyl chloride to react upon mesitylene in presence of anhydrous aluminium chloride. The new compound—

$$C_6H_2(C_7H_7)(CH_3)_3$$

forms when pure a white crystalline mass, faintly tinted with yellow, easily soluble in benzine, light petroleum ether, alcohol, ether, acetic acid, and acetone. It melts at 31°.

December 11, 1882.

Separation of Gallium.—M. Lecoq de Boisbaudran.—Will be inserted in full.

New Researches on Glairine and Baregine, and on its Formation in the Thermal and Sulphurous Waters of the Pyrenees.—M. N. Joly.—Concrete glairine is a very complex substance containing the remains of a multitude of animals and vegetables, as well as crystals of sulphur, pyrites, silica, &c.

Instance of Black appearing Orange-Red.—M. A. Trécul.—The author observed last summer a lady wearing a black veil consisting of a net-work of very close meshes and directly illuminated by the sun. All the knots of the net-work appeared externally of an orange-red, whilst the inner half remained black. The black of the dyers is a very intense blue, to which an orange-red is complementary.

Communication of M. Marcel Deprez, relating to the Transfer of Force.—M. Maurice Lévy.—Not suitable for abstraction.

Atomic Weight of Gallium.—M. P. T. Clève.—Will be inserted in full.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 9.

Manurial Experiments on Potatoes with Potash-Saltpetre.—Dr. Edler.—The results of the experiments were favourable both financially and as compared with soda-saltpetre.

Researches on Manuring Vineyards.—Prof. Paul Wagner.—Neither phosphoric acid nor potash have had any effect in the experiments at Bodenheim. At Nierstein the action of phosphoric acid was unfavourable, the yield being 25 per cent less than in its absence. The leaves of the vines took a yellowish colour as early as August, whilst in the unmanured portions the leaves had a normal appearance.

Comparative Manurial Experiments in the District of the Freudenberg Agricultural Association.—The addition of either potash or phosphoric acid singly did not cover the cost. Both together proved remunerative.

Experiments on the Digestion of Lupins (Freed from their Bitter Principle) by Horses, and Observations on the Comparative Working Power of the Horse when Fed on Lupins or Oats.—Dr. O. Kellner.—The comparative food value of lupins and oats does not essentially vary.

Composition of the Albumenoids of Hemp Seeds, and of the Crystalline Albumen of Hemp Seeds and Castor-Oil Nuts.—H. Ritthausen.—The crystalline albumen of hemp seed and that of the castor oil nut appear identical; that of the pumpkin seed differs in its composition.

Cultivation of Sugar Beets.—W. Rimpau, L. Dehaussy, and B. Corenwinder.

Cultivation of the Potato.—Prof. Leydhecker, Profs. Wollny, Ring, L. Meyer, and others.—These papers are not of a chemical character.

Diseases of the Sugar Beet.—Prof. Kühn and H. Joulie.—Phenol-lime and a secret remedy have not proved successful. A copious dressing with potassic manures is recommended.

Phylloxera and its Antidotes.—Not adapted for abstraction.

Researches on Parasitic Diseases of Plants and their Remedies.—*Silpha reticulata*, *S. atrata*, and *S. opaca* are now well known as enemies of the sugar beet.

Cosmos Les Mondes.
No. 11, November 11, 1882.

Mutual Attraction and Evaporation.—Everyone knows that the magnet attracts iron. Setting out on this principle it would seem natural to admit that the degree of attraction of an ore would be directly proportional to its richness in iron. Experience points to a contrary result. The sulphides and sulphates are less attracted by the magnet than the oxides, carbonates, and silicates, though containing more iron. No practical application has yet been made of this discovery (?), yet different ores might be mechanically separated from each other, which would much facilitate their treatment and reduction. Metals follow for evaporation the laws of other bodies. Their volatilisation requires a very high temperature. But M. Demarçay has remarked that this temperature diminishes notably with pressure. If it were practicable to smelt metals in a vacuum, a much lower heat and a smaller quantity of fuel would be required.

No. 12, November 18, 1882.

Silico-molybdates.—F. Parmentier.—The author describes the ammonium, potassium, silver, and mercurous silico-molybdates.

Solubility of Certain Mercuric Compounds in Benzol.—A. P. N. Franchimont.—Mercuric chloride, bromide, and iodide dissolve slightly in benzol when cold, and much more when it is warm, and crystallise out on slow cooling or on spontaneous evaporation. The compounds of lead and copper are insoluble in benzol.

No. 13, November 25, 1882.

The Société Génerale des Telephones has seized all the telephones existing at present in the hands of all the French makers.

Preparation of Precipitated Tin.—C. Puscher.—The author uses a very dilute solution of stannous chloride, strongly acidulated, containing 150 grms. tin crystals in 68 litres of water. The sponge of tin which is deposited by the action of bars of zinc is collected without pressure in a sieve, washed in water, and then dried in heat. The powder is mixed with starch-paste, and may be used for printing or coating cloth, paper, &c.

No. 14, December 2, 1882.

Production of Gold in French Guyana.—The production of gold from the mine of French Guyana is about 2500 kilos. yearly.

The New Telephone of M. Maiche.—The description of this apparatus requires the two accompanying illustrations.

New Accumulator with Carbon Electrodes.—Dr. D. Tommasi.—The author's accumulator or secondary battery has several advantages as compared with those already in use. It weighs, bulk for bulk, from five to six times less. It presents a surface of lead exceedingly large as compared with the weight of the carbon plate, and it can be put together very rapidly.

MEETINGS FOR THE WEEK.

Monday, Jan. 1.—London Institution, 5.
Tuesday, 2nd.—Royal Institution, 3. "Light and the Eye," by Professor Tyndall.
—— Pathological, 8.30.
Thursday, 4th.—London Institution, 7.
—— Royal Institution, 3. "Light and the Eye," by Professor Tyndall.
Saturday, 6th.—Royal Institution, 3. "Light and the Eye," by Professor Tyndall.

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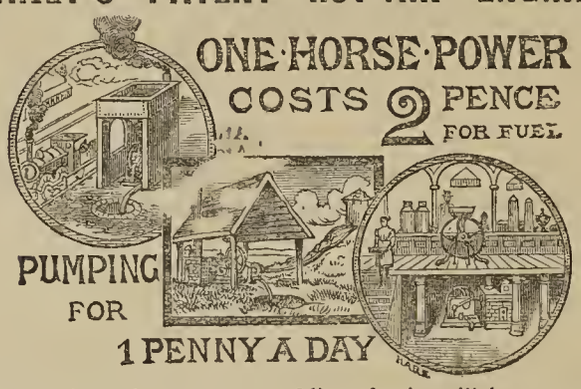

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INDEX.

ABERCROMBY, R., certain types of British weather, 241
and W. Marriott, popular weather prognostics, 300
Acet-acetic ester, 114
Acetanilide, 291
Acetate of copper, decomposition of, 292
tertiary amyle, decomposition of by heat, 207
Acetone, action of anhydrous aluminium chloride upon, 184
Acid, acetic, behaviour of dolomite with, 12
arsenic, behaviour of with sugar, 13
boracic, determination of, 286
boric, 36
carbonic, antiseptic properties of, 283
and phenol, unstable compound of, 149
free, 25
hydrochloric, 233
electrolysis of, 208
pure, preparation of, 184
hydrocyanic, various properties of, 23
hypophosphoric, preparation of, 114
isophthalic, derivatives of, 172
malic, in mountain ash berries, 68
methacrylic, 124
molybdic, hydrate of, 254
myronic, in oil-cake, 185
nitric, and ammonia in the glaciers of the Alps, 302
para-oxybenzoic, two anhydrides of, 173
phosphoric, agricultural value of different combinations of, 185
estimation of as magnesic pyrophosphate, 213
new method for determining, 4
phthalic, compounds of with the phenols, 78
reaction in certain kinds of paper, cause of, 183
salicylic, determination of, 243
sulphuric, proportion of in red wines, 209
testing for, or barium, 223
volumetric estimation of, 221
Acids, amidic certain new, 291
bibasic, imides of, 280
bile, modification of Pettenkofer's reaction for, 119
combined with mercuric oxide, reciprocal displacements of, 34
dihydroxy-benzoic and iodosalicylic, 219
tartaric and citric, contributions to the chemistry of, 239
Ackroyd, W., production of rainbows, 251
Adepsine, 150
Agaricus Ruber, colouring-matter and alkaloid in, 199
Agricultural College, Downton, 173
Royal, Cirencester, 132
lectures, 173
Agronomic examination of soils, 123
Air, electrisation of, 280
Albo-carbon burners, 257
Albumenoids, malt, varying quantities of extracted by waters of different types, 220
of hemp-seeds, composition of, 303
quantitative determination of, 160, 185
Alcohol, allylic mono-chloric, 254
Alcoholic liquids, passage of through porous bodies, 254
Alcohols, poly-atomic, 160
Alexeew, W., reciprocal solutions of liquids, 256
Algiers, coal in, 232
Alkaline chlorides, poisonous power of the, 23
earthy carbonates contained in waters, volumetric determination of, 302
potassium permanganate solution used for water analysis, 284
Alkaloid and colouring-matter in Agaricus Ruber, 199
Alkaloids in their salts, new method of recognising, 243
new colour reactions of, 268
Allen, A. H., action of water on lead, 145, 170
Allylic monochloric alcohol, 254
Alumina in presence of ferric oxide, determination of, 12
Aluminium, action of upon cupric chloride, 62
sulphate from bauxite, 256
Aluminum, pure metallic, properties of, 178
revision of the atomic weight of, 15, 27, 41
Alum spring, the Orchard, 226
Alunite in powder, calcination of, 291
raw, industrial richness of, 200
Amagat, E. H., elasticity of rarefied gases, 107
Amalgamation process, Mexican, reactions of the, 177
American Association for the Advancement of Science, 115, 167
Amides of acids, action of phosphorus penta-chloride upon the, 255
transformation of into amines, 207
Amidic cids, certain new, 291
Ammonia, action of upon copper oxide, 103
and nitric acid in the glaciers of the Alps, 302
in potable waters, estimation of, 247
Ammoniacal compounds, rhodium, 67
Ammonium citrate, detection of lead in presence of, 184
Amylic alcohol, commercial, organic bases in, 268
Amylose, estimation of dextrose, maltose, and dextrin in, 175
Analcime, artifical production of, 67
Analyses, commercial, 148
of guano in Australia, 260
of Indian wood, 187
of tobacco ash, 248
Analysis of beer, 244
of certain vegetable fibres, 240
of potash made from Kyathourg bamboo, 51
of smoke gases, 12
of water, 227, 237, 267
Anderson's College, Glasgow, 136
Andreasch, M., studies on caffeine and theo-bromine, 78
Anethol, action of nitrous acid upon, 160
Anhydride and phenol, compound of, 149
second, of mannite, 285
Anhydrides of para-oxy-benzoic acid, 173
Anhydrous aluminium chloride, action of upon acetone, 184
Aniline dyes, 245
Anthraquinon series, reduction experiments in the, 67
Antimonial poisoning, chronic, 208
Antimony and tin, determination and separation of, 172
separation of, 268
copper, and iron, volumetric determination of, 285
separation of tungsten from, 13
tartrates, constitution of the, 160
Antisepsis, theory of, 58
Antiseptics, properties of, 269
two new, 66
Aqueous solution, arsenic sulphide in, 124
Arable soil, reduction of nitrates in, 232
Archibald, E. D., use of kites for meteorological observations, 241
Argentous oxide, 11
"Arithmetic, Elementary Chemical" (review), 102
"Arithmetical Chemistry" (review), 231
Armstrong, D., constitution of lophin, 274
Arnold, C., new colour reactions of the alkaloids, 268
Arsenic acid, behaviour of with sugar, 13
compounds, poisoning by, 233
in copper, determination of, 46, 77
microscopical detection of, 184
sulphide in aqueous solution, 124
Arseniates, certain, neutral to litmus paper, 122
Arts, Society of, 245
Association, British, 79, 95, 104, 120
Atmospheric nitrification, 280
Atomic weight of aluminum, revision of the, 15, 27, 41
of [illegible]cinum, 159
of thorium, 232
Augustin, F., daily course of rainfall, 184
Austen, P. T., precipitation of stannic oxide, 286
and G. B. Hurff, reduction of ferric solutions, 287
and F. A. Wilbur, tube-stand for Nesslerising, 298
Avogadro, new law analogous to the law of, 291
Ayrton and Perry, Profs., resistance of the voltaic arc, 288
Azaurolic acids, 255
"Azobihydre," existence of, 89

BABO, M., and C. Portele, solubility of potassium bitartrate, 233
Baeyer, A., compounds of phthalic acid with the phenols, 78
"Ballarat School of Mines" (review), 242
Baregine and glairine, 303
Barium or sulphuric acid, testing for, 223
sulpho-cyanide, adulteration of, 268
Barth, M., hygienic signification of drinking-water, 149
and J. Nessler, analysis of wine, 11
Baryta, sodium tungstate as a reagent for, 12
Bass fibres, chemistry of, 240
Battery, chemical work produced by, 77
Baubigny, H., action of heat upon a solution of acid nickel sulphate, 11
action of sulphuretted hydrogen, 17
upon nickel chloride, 40
transformation of amides into amines, 207
Baumert, G., behaviour of lupinine with dehydrating agents, 255

Bauxite, aluminium sulphate from, 256
Béchamp, A., hæmatosine, 35
Beer, analysis of, 244
examination of, 23
salt in, 46
Beet-dregs, products of the distillation of, 185
Beet-root, potassium salts as manure for, 159
Beilstein, F., and A. Kurbatow, nature of the Caucasian petroleum, 160
Bellini, M., poisonous action of the lupin, 233
Benzol, constitution of, 160
law of the congelation of the solutions of neutral substances in, 77
solubility of certain mercuric compounds in, 303
Benzyl compounds, substituted, 44, 52
Berries of mountain ash, malic acid in, 68
Berthelot, M., electrolysis of oxygenated water, 46
electromotor force of a zinc-carbon element, 46
lead iodide, 290
reciprocal displacements of acids combined with mercuric oxide, 34
of the halogens, 23
use of zinc-coke elements in electrolysis, 10
and M. Ilosvay, characters and functions of the double salts formed by fusion, 10
and M. Vieille, diazo-benzol nitrate, 35
period of variable condition which precedes detonation, 103
Besana, M., boric acid, 36
Bevan, E. J., and C. F. Cross, chemistry of bass fibres, 240
Beyer, B., derivatives of isophthalic acid, 172
Bibasic acids, imides of, 280
Bichat, E., and R. Blondlot, oscillations of the plane of polarisation by the discharge of a battery, 10
Biebrich scarlet, 160
Biedermann, R., "Chemiker Kalender" (review), 206
Bile pigments, reactions of, 268
Billaudot, M., treatment of an ore of selenium, 60
Bing, J., what is most needed in chemical laboratories? 188
Biselenide and tin bisulphide, certain compounds of, 207
Black appearing orange-red, 303
Blance, H., importing atmospheric air, 170
Blas and Miest, MM., electro-metallurgic process, 93
extraction of precious metals from ores, 121
Blondlot, R., and E. Bichat, oscillations of the plane of polarisation by the discharge of a battery, 10
Blood, disinfection and agricultural utilisation of, 24
"Blowpipe Analysis, Quantitative and Qualitative" (review), 265
Blue, Prussian, in Turnbull's blue, solubility of, 12
Boillat, F., theory of antiseptics, 58
Bolton, H. C., chemical literature, 115, 146, 153, 166
"Students' Guide in Quantitative Analysis" (review), 112
Bone-black, new substitutes for, 124
Böttiger, R., detection of ozone, 12
Bordet, M., and L. Cailletet, certain hydrates formed by pressure and release, 57
Boracic acid, determination of, 286
Boric acid, 36
Bourcart, R., and E. Noelting, action of sulphuric acid upon proto-catechuic acid, 36
Bourgeois, L., artificial production of crystalline carbonates, 67
Boussingault, M., appearance of manganese on the surface of rocks, 122, 149
nitric acid and ammonia in glaciers of the Alps, 302
Boutmy, H., note on explosives, 161
Braithwaite, W. and J., "Retrospect of Medicine" (review), 21
Brame, C., various properties of hydrocyanic acid, 23
Brard, M., currents produced by nitrates, 280
Brauner, B., certain earths in cerite, 268
note on didymium, 16
metals of cerite, 249
Bread, presence and determination of copper in, 92
Reform League, 269
Briem, H., manurial results with osmose water, 123
Bristol University College, 13
British Association, 79, 95, 104, 120
weather, certain types of, 241
Bromine, action of upon quinoleine and pyridine, 57
derivatives of naphthalene, 241
Brown, W., conservation of energy and central forces, 230
Brucine, 300
pyridic bases derived from, 114
Bruneau and Miron, MM., reproduction of calcite and witherite, 77
Brunner, M., new reagent for sulphur and nitro-benzol, 92
Bungener, H., analysis of beer, 244
Burcker, M. E., volumetric determination of potassa, 233
Buisson, M., volumetric determination of lead, 48
Burettes, preparation and correction of, 149
Burg, O., picene, 160
Butter, rancid, 150
spurious, detection of, 281
Butyrate, calcium, crystalline water of, 78
Buxton thermal water, new analyses of, 201
Byasson, H., determination of the nitrogenised matters of urine, 92

CÆSIUM and rubidium, 249
Caffeine, 8
and theo-bromine, studies on, 78
Cailletet, L., and M. Bordet, certain hydrates formed by pressure and release, 57
Calcic hypo-chlorite, 120, 148
Calcite and witherite, reproduction of, 77
Cambridge University, 128
Camphor, dichlorated, case of isomerism of, 114
Capranica, E., reactions of the bile pigments, 268
Carbon disulphide, determination of, 2
electric arc in the vapour of, 43
electrodes, new accumulator with, 303
Carbonates, alkaline earthy, volumetric determination of contained in waters, 302
crystalline, artificial production of, 67
Carbonic acid and phenol, unstable compound of, 149
antiseptic properties of, 283
surface-tension of certain liquids in contact with, 122
Carbonic oxide and oxygen, explosion of, 151
Carboniferous substances, determination of sulphur in, 13
Carbonising, 48
Carles, P., plastered and deplastered wines, 104
yolk of egg 92
Carnallite as a manure, 149
Carré, F., destruction of the germs of parasites, 57
Casamajor, P., detection of glucose in cane-sugar, 24
note on filtering discs, 8
Catalytic reaction, new, 9
Cazeneuve, P., case of isomerism of dichlorated camphor, 114
Cellulose, limits of nitrification of, 66
oxidation of, 240
Cement, natural, 187
Cerite, certain earths in, 268
metals of, 249
Chaudelon, T., volumetric determination of phenol, 196
Chapoteau, P., gastric juice, 35, 66
Chatreau, N., and M. Jacobs, application of the law of complementary colours, 243
Chemical composition of lava, 23
Industry, Society of, 56
laboratory at Greifswald, 281
of Royal School of Forestry at Aschaffenburg, 185
of the University of Graz, 78
of Wiesbaden, 114
laboratories, What is most needed in, 188
lectures, classes, and laboratory instruction, 137
literature, 115, 146, 153, 166
manures applicable to the sugar-cane, 24
notes, 255
reactions, certain, influence of gum arabic in, 233
reagents, pure, manufacture of, 233, 245
School of Mulhouse, 35
Section, Address to, 97
Society, 219, 239, 273, 299
Newcastle, 251, 261, 275
Russian, 78, 114, 255, 256, 292
studies on sugar-beet, 254
transformations, influence of mass upon, 172
work produced by the battery, 77
"Chemical Arithmetic, Elementary" (review), 102
"Chemiker Kalender, 1883" (review), 206
Chemistry and courtesy in Germany, 112, 148
of hay and "ensilage," 275
Institute of, 48, 193
Liverpool College of, 133
of nymphaceæ, 268
of tartaric and citric acids, contributions to, 239
of tobacco, 11
practical, in the University of Virginia, 194, 204, 215
Schools of, 127, 146
South London School of, 48
"Chemistry, Arithmetical" (review), 231
"Chemistry, Modern Elementary, Catechism of" (review), 21
"Chemistry, Synopsis of" (review), 232
Cheques, safety, 196
Chevreul, M., vision of colours, 290
Chittenden, R. H., and J. S. Ely, influence of peptones on the diastatic action of saliva, 180, 189
Chloral hydrate, detection of, 13
Chloride, action of anhydrous aluminium upon acetone, 184
of lime and chloride of lithia, 255
detection of in water, 43
Chloride, platinum, and ammonium molybdate, recovery of, 243
Chlorides, alkaline, poisonous power of the, 23
Chloro-bromide, derivatives of ethylene, 220
Chloroform, action of upon naphthol, 47
detection of, 243
Cholesterines, 149
Chrom-ammoniacal compounds, 124
Chroustchoff, P., heat of solution of some mixtures, 103
Cigar lighter, dangerous device in the shape of, 25
Cinchona, assays of, 117
Cinnamic acid, para- and ortho-nitro-, certain derivatives of, 67, 68
Cirencester Royal Agricultural College, 132
Citrate, ammonium, detection of lead in presence of, 184
Citric and tartaric acids, contributions to the chemistry of, 239
Clarke, F. W., and H. Stallo, constitution of the antimony tartrates, 160
Classen, M., chemical notes, 255
Clémandot, L., coercitive force of steel rendered permanent by compression, 184
Clève, M. P. T., didymium, 43
Coal and coke, estimation of nitrogen in, 299
in Algiers, 232
tar, distillation of, 36
"Coal-tar, Distillation of" (review), 157
Cobenzl, A., separation of tungsten from antimony, 13
Coke and coal, estimation of nitrogen in, 299
Colchicine, detection of, 24
College, Anderson's, Glasgow, 136
Firth, Sheffield, 135
King's, 128
of Agriculture, Salisbury, 173
of Chemistry, Liverpool, 133
of Science, Royal, for Ireland, 137
Queen's, Belfast, 137
Cork, 137
University, 129
Liverpool, 133
Nottingham, 135
Wales, 131
Yorkshire, 132
Colleges and Universities, 126
Collidine, physiological action of, 233
Colloids, nitrogenous, 196
Colophonium, products of the distillation of, 66
Colour of certain precious stones, cause of, 33
Colouring-matters, certain, fixation of by means of metallic mordants, 179
"Colours and Dye-Wares, Manual of" (review), 9
Colours, complementary, application of the law of, 243
various, electro-chemical deposits of, 290
vision of, 290
Colson, A., and P. Schützenberger, silicium, 35
Combes, M., alleged compound NH_2, 35
Combustion, flameless, 22, 37
Comets and electricity, 207
Compound NH_2, alleged, 35
Constam, E. J., and V. Meyer azaurolic acids, 255
Copper acetate, decomposition of, of, 292
and lead salts, behaviour of with soda lye, 120
determination of arsenic in, 46, 77
iron, and antimony, volumetric determination of, 285
oxide, action of ammonia on, 103

Copper, lead, and zinc smelting works, injurious constituents of the smoke of, 208
precipitation of by electrolysis, 150
presence and determination of in bread, 92
sulphate, dissociation of, 123
Corne, J., phosphorescence and oxidation of phosphorus, 92
preparation of hypophosphoric acid, 114
Cornwall, H. B., "Qualitative and Quantitative Blowpipe analysis" (review), 265
Cotarnine, 68
Cotton, silk, and wool, absorption of weak reagents by, 299
Crafts, J. M., comparison of the mercurial thermometer with the hydrogen thermometer, 254
mercurial thermometer, 280
Craig, G., estimation of iron and steel, 272
of sulphur in iron and steel, 199
Crampton, C. A., sugar analysis, 22
Creosote, detection of phenol in, 244
Criper, W. R., analyses of Indian wood, 187
Croft, H. H., rattlesnake poison, 165
Crookes, W., and G. Ville, "Artificial Manures" (review), 168
W. Odling, and C. M. Tidy, London water supply, 17, 107, 153, 191, 236, 297
Cross, C. F., and E. J. Bevan, chemistry of bass fibres, 240
Cudbear, magenta, and orchil, detection of in wine, 123
Cuisinier, L., the saccharines, 48
Cuno, E., and B. Wittgen, preparation of potassium carbonate from potassium chloride, 267
Cupric chloride, action of aluminium upon, 62
Cuprous sulphites, derivatives of, 66
Curie, P., and M. Jacques, electric deformations of quartz, 260
Curtius, T., new amidic acids, 291
Cyanic compounds, new class of, 66
"Cyanures," 104

D'ABBADIE, M., miasmatic fevers, 171
Davy, E. W., determination of the nitrites, 1
De Cew, G.G., "Magneto-electric and Dynamo-electric Machines" (review), 230
De Coninck, O., pyridic bases derived from brucine, 114
and M. Marcus, physiological action of collidine, 233
De Forcrand, M., hydrated hydrogen sulphide, 66
De Schulten, A., artificial production of analcime, 67
Debray, H., reproduction of iridium osmides, 280
Decaux, M., rational method for the study of dyeing, 51
Decharme, C., hydro-dynamic experiments, 122, 149
"Dégras," composition and analysis of, 24
Dehérain, P. P., cultural experiments on the field at Grignon in 1881, 184
and M. Maquenne, reduction of nitrates in arable soils, 208, 232
Deibel, H., curious laboratory explosion, 267
Delacharlonny, P. M., new ferric sulphates, 36
Demarcay, E., evaporation of metals in a vacuum, 77
Deprez, M., electromotive force of a magneto-electric machine, 10
transmission of work to a distance by means of telegraphic line, 207
Detonation, period of variable condition which precedes, 103
Deville, H. St. C., explosive alloys of zinc and of the platinum metals, 10
Dewar, J., and G. D. Liveing, origin of the hydrocarbon flame spectrum, 293
Dextrose, maltose, and dextrin, estimation of in amylose, 175
Diamond, origin and formation of in nature, 105
"Diaries for 1883, Lett's" (review), 242
Diazo-benzol nitrate, 35
Diazo-derivatives of nitro-benzyl-cyanide, 300
Dichlorated camphor, case of isomerism of, 114
Didymium, 16, 43
Dietzell, B. E., liberation of gaseous nitrogen in putrefaction, 159
Digeon, L., testing the germinating power of seeds, 209
Dihydroxy-benzo c acids and iodo-salicylic acids, 219
Dinitro-quinine mono-hydrate, 93
Diploma trade, 48
"Directory of Gas and Water Companies" (review), 76
Dirks, V., myronic acid in oil-cake, 185
Discs, note on filtering, 8
Disulphide, carbon, determination of, 2
Ditte, A., certain compounds of tin bisulphide and biselenide, 207
decomposition of salts, 10
production of certain crystalline uranates by the dry way, 290
Divers, E., Lec anché cell, 259
Dixon, H. B., explosion of carbonic oxide and oxygen, 151
Dolomite, behaviour of with acetic acid, 12
Donath, E., determination of alumina in presence of ferric oxide, 12
separation of silver from lead, 13
Doney, M., detection of spurious butter, 281
Dragendorff, H., examination of beer, 23
Drewsen, V. B., derivatives of para-nitro-cinnamic acid, 68
Drinkwater, T. W., "Synopsis of Chemistry" (review), 232
Dreyfus, M. E., determination of potassa in manures, 212
Duisberg, C., acet-acetic ester, 114
Dumont, M., novel transformation of petroleum oil, 161
Dung of deep stalls, 123
Dupetit and Gayon, MM., fermentation of nitrates, 207
Durham, University of, 133
"Dye Wares and Colours, Manual of" (review), 9
Dyes, new method of detecting on yarns and tissues, 211, 250, 260
Dyeing and printing, application of electrolysis in, 89
new work on, 166
rational method for the study of, 51
"Dynamo-electric and Magneto-electric Machines" (review), 230

EDER, J. M., quantitative determination of ferrous oxide, 12
reducing action of potassium ferrous oxalate, 12
Edinburgh University, 136
Egg, yolk of, 92
Electric arc in the vapour of carbon disulphide, 43
reaction current of, 23
deformations of quartz, 260
furnace, 163
lighting by incandescence, 49, 59, 114
prevention of fire risks from, 7
resistance of glass at low temperatures, 103
wires, insulating, 122, 149
Electricity and comets, 207
objections to the theory of, 207
useful application of, 301
"Electricity and Magnetism, Elementary Lessons in" (review), 278
Electrisation of the air, 280
Electro-chemical deposits of various colours, 290
Electrolysis of oxygenated water, 46
use of in dyeing and printing, 89
zinc-coke elements in, 10, 34
Electrolytic method, separations and determinations of metals by the, 105
precipitations of metals by, 255
Electro-metallurgic process, 93
Electromotive force of a magneto-electric machine, 10
Electromotor force of a zinc-carbon element, 46, 57
Ellenberger and Hofmeister, MM., digestive secretions of the horse, 159
Emmerling, A., and G. Loges, dung of deep stalls, 123
Ely, J. S., and R. H. Chittenden, influence of peptones on the diastatic action of saliva, 180, 189
Energy and central forces, conservation of, 230
Ester acid, acetic, 114
Etard, A., derivatives of the cuprous sulphites, 66
isomerism of cuprous sulphites, 47
and A. Gautier, mechanism of putrid fermentation, 10
and L. Oliver, reduction of sulphates by living beings, 254
Ethylen, chloro-bromide, derivatives of, 220
diamin, preparation of, 63
Evaporation and mutual attraction, 303
Examination question, 220
Explosion, curious, 281
laboratory, 267
Explosions, process for avoiding, 172
note on, 161

FAHLBERG, C., aluminium sulphate from bauxite, 256
Farrington, T., secondary battery, 183
Fassbender, G., quantitative determination of albumenoids, 160
Fauconnier, A., second anhydride of mannite, 285
Feichtinger, M., acid reaction in certain kinds of paper, 183
Fermentation, putrid, mechanism of, 10
Ferric hydrate, isomeric modification of a, 93
hydrates, researches on, 256
oxide, determination of alumina in presence of, 12
solutions, reduction of, 287
sulphates, new, 36
Ferrocyanide, sodium, determination of in soda, 11
Ferrous oxide, quantitative determination of, 12
Fesca, M., agronomic examination of soils, 123
Filhol and Senderens, MM., certain arseniates neutral to litmus-paper, 122
Filtering discs, note on, 8
Firth College, Sheffield, 135
Fish offal, 269
Fischer, E., hydrazine compounds, 78
Fittbogen, J., use of carnallite as a manure, 149
Flame in combustible gaseous mixtures, nature of vibratory movements which accompany the propagation of, 184
Fleck, H., permeability of soils and building materials, 11
Fletcher, T., flameless combustion, 22, 37
Flour, determination of ash in, 12
Foehr, K. F., sources of error in determining iron in ores by the stannous chloride method, 40
Forbes, G., velocity of light of different colours, 288
Forestry, Royal School of at Aschaffenburg, communications from the Chemical Laboratory of, 185
Foster, W., estimation of nitrogen in coal and coke, 299
Foussereau, G., electric resistance of glass at low temperatures, 103
Franchimont, A. P. N., solubility of certain mercuric compounds in benzol, 303
Francken, V., separations of metals by the electrolytic method, 105
Francon, M., novel transformation of petroleum oil, 161
Fréyon, Dumont, and Francon, MM., novel transformation of petroleum oil, 161
Freytag, M., injurious constituents of the smoke of copper, lead, and zinc smelting works, 208
Fusion, evaporation without, 160

GAL, H., passage of alcohol in liquids through porous bodies, 254
rotatory power of glucose, 292
Galaktine, 255
Gallium, protochloride, decomposition of by water, 46
separation of, 3, 69, 152, 165, 211
Gangue, process for the separation of sulphur its, 254
Gas dissolved in a liquid, influence of upon its surface tension, 113
"Gas Works' Statistics" (review) 76
Gases, explosive, phenomena in, 77
rarefied, elasticity of, 107
Gaseous nitrogen, liberation of in putrefaction, 159
Gastric juice, 35, 66
Gautier, A., and A. Etard, mechanism of putrid fermentation, 10
Gayon and Dupetit, MM., fermentation of nitrates, 207
Geissler, E., valuation of German yeast, 22
Gelatine and glue, improvements in, 267
Geoffroy, H., insulating electric wires, 122
Gerber, M., and A. Rosenstiehl, conditions of the formation of the rosanilines, 104
German yeast, valuation of, 22
Germs, living, development of in water, 289
Gintl, W., solubility of Prussian blue in Turnbull's blue, 12
Girard, A., composition of wines prepared by Petiot's process, 104
determination of astringent matters in wines, 77
Gladding, T. S., absolute determination of nitrogen, 39
determination of reverted phosphates, 18, 31

Gladding, T. S., estimation of phosphoric acid as magnesic pyrophosphate, 213
Glairine and baregine, 303
Glass, electric resistance of at low temperatnres, 103
stoppers, rem val of, 286
Glasses, technical examination of, 11
Globulariæ, researches on the, 57
Glucinum, atomic weight of, 159
oxides, hydrates of, 291
Glucose, detection of in cane-sugar, 24
specific rotatory power of, 292
Glycerin, reducing action of, 245
Goppelsrœder, F., application of electrolysis in dyeing and printing, 89
Gorgen, A., basic salts of manganese, 57
Graebe, C., reactive power of the naphthols, 160
Grandeau, H., decomposition of phosphates by potassium sulphate, 280
L., manurial experiments on the trial field of Nancy, 123
Grape-sugar, preparation of, 208
Graz University Chemical Laboratory, 78
Green, vanadium, 268
Griefswald, Chemical Laboratory at, 281
Grete, E. A., and J. Macagno determination of carbon disulphide, 2
Griffith, H., "Irenicon" (review), 75
Griffiths, A. B., analyses of guano in Australia, 260
origin and formation of the diamond in Nature, 105
Grignon, cultural experiments on the field at, 184
Grimaux, E., action of bromine upon quinoleine and pyridine, 57
nitrogenous colloids, 196
Groshaus, J. A., new law analogous to the law of Avogadro, 291
Grosjean, B. J., contributions to the chemistry of tartaric and citric acids, 239
obituary, 76, 104
Grothe, O., artificial vaniline, 243
Growth, researches on the inner causes of, 123
Gruber, M., purification of ozokerite, 243
Grüning, W., chemistry of the nymphaceæ, 268
Guano in Australia, analyses of, 260
Guckelberger, G., ultramarine, 114
Guidice, M., preparation of pure hydrochloric acid, 184
Guillaum, L., manurial experiments on the action of natural phosphates, 123
Gum arabic, influence of in certain chemical reactions, 233
Guyard, A., determination of zinc, 220, 221
preparation of oxygen, 221
volumetric determination of sulphuric acid, 221
Guyot, P., calcination of alunite in powder, 291
industrial richness of raw alunite in powder, 200

HAAS, B., detection of magenta, orchil, and cudbear in wine, 123
Hæmatosin, 35
Hagemann, M., analyses of smoke gases, 12
Hager, H, detection of arsenic microscopically, 184
Haidinger, L., organic bases in commercial amylic alcohol, 268
Haines, R., water analysis, 227, 237
Haller, A., new class of cyanic compounds, 66
Halogens, reciprocal displacements of, 23
Harland, R. H., sugar analysis, 45
Harris, F. L., carbonising, 48
Hartley, A., and E. M. Moritz, varying quantities of malt albumenoids extracted by waters of different types, 220
Horse, digestive secretions of the, 159
Hastings, C. W., "Water Works Statistics, Gas Works Statistics, Gas and Water Companies Directory" (review), 76
Haswell, A. E., phosphorus in iron and steel, 23
Haushofer, K., behaviour of dolomite with acetic acid, 12
Hay, chemistry of and "ensilage," 275
Heat, action of upon a solution of acid nickel sulphate in presence of sulphuretted hydrogen, 11
Hecht, O., crystalline water of calcium butyrate, 78
Heckel, E., J. Mourson, and F. Schlagdenhauffen, researches on the Globulariæ, 37
Henry, L., allylic mono-chloric alcohol, 254
Hertel, J., detection of colchicine, 24
Hesse, O., hydro-cinchonidine, 185
Hiepe, W. L., determination of traces of organic matter in potable water, 23
Hinteregger, M. studies on caffeine and theo-bromine, 78
Hirn, G. A., efficacy of lightning conductors, 244
Hofmeister, M., and M. Ellenberger, digestive secretions of the horse, 159
Holland, P., water analysis, 267
Houzeau, A., volumetric determination of the alkaline earthy carbonates contained in waters, 302
Huddersfield lead-poisoning case, 88, 145
Huet, A. J., gelatine and glue, 267
Huntington, A. K., and C. W. Siemens, electric furnace, 163
Hurff, G. B., and P. T. Austen, reduction of ferric solutions, 287
Hydrate, chloral, detection of, 13
Hydrated hydrogen sulphide, 66
Hydrates, ferric, researches on, 256
formed by pressure and release, 57
of glucinum, 291
Hydrazine compounds, 78
Hydrocarbide, new, 302
Hydrocarbon flame spectrum, origin of, 293
Hydrocarbonate, sodium, analysis of, 245
Hydrocarbons, 120
Hydrochloric acid, 233
electrolysis of, 208
gas, action of at elevated temperatures, 161
pure, preparation of, 184
Hydro-cinchonidine, 185
Hydrocyanic acid, various properties of, 23
Hydro-dynamic experiments, 122, 149
Hydrogen, expansion of the spectral rays of, 149
nascent, 256
peroxides, 221, 268
process for the industrial and economical production of, 161
sulphuretted, action of, 17
action of upon nickel chloride, 40
Hydroquinones and quinones, 269
Hygienic signification of drinking water, 149
Hypochlorite, calcic, 120, 148
Hypophosphoric acid, preparation of, 114

ICE-MACHINE and patent vacuum pump refrigerator, 192
Ilosway, M., and M. Berthelot, characters and functions of the double salts formed by fusion, 10
Imides of bibasic acids, 280
Incandescence, electric lighting by, 114
Induline group, researches on, 300
Institute of Chemistry, 48, 193
Institution, Royal, 36, 230, 275
Invalids and children, articles of diet for, 209
Iodide of lead, 290
Iodides, phosphorus, equivalent of the, 113
Iodo-salicylic acids and dihydroxy-benzoic acids, 219
"Irenicon" (review), 75
Iridium osmides, reproduction of, 280
Iron and steel, estimation of, 272
estimation of sulphur in, 199
phosphorus in, 23
in ores, errors in determining, 40
sanitary properties of, 93
Isomeric modification of a ferric hydrate, 93
Isomerism of cuprous sulphites, 47
of dichlorated camphor, case of, 114
Isomorphism, 93
modification of the expression of the law of, 243
Isophthalic acid, certain derivatives of, 172

JACKSON, C. L., and A. E. Menke, certain substances from turmeric, 61, 70
and J. F. White, substituted benzol compounds, 44, 52
Jacobs, M., and N. Chatrian, application of the law of complementary colours, 243
Jacobson, P., and C. Liebermann, formation and constitution of naphtho-quinone, 209
Jacques, M., and P. Curie, electric deformations of quartz, 260
James, J. W., derivatives of ethylene chloro-bromide, 220
Jamin, M., and G. Maneuvrier, electric arc in the vapour of carbon disulphide, 43
reaction current of the electric arc, 23
Janssen, J., telluric rays, 280
Japanese soils, 187
Japp, F. R., constitution of lophin, 241
Jean, F., Composition and analysis of "Dégras," 24
Jehn, M., and M. Wüsthoff, detection of strontianite, 268
Jevons, Prof. W. Stanley, obituary, 76
Joannis, M., formation heats of the principal palladious compounds, 113
Joffre, J., detecting dyes on yarns and tissues, 211, 250, 260
Johanson, E., malic acid in mountain ash berries, 68
Joly, N., glairine and barigine, 303
Jörgensen, S. M., chrom-ammoniacal compounds, 124
rhodium ammoniacal compounds, 67
Joulie, H., judicious use of manures, 24
lowering the production cost of wheat, 36

KAISTALBA, M., substitute for a sand bath, 281
Kaolin, action of wine upon, 268
Kappel, S., formation of ozone and hydrogen peroxide, 268
Kayser, R., action of wine upon kaolin, 268
Kienlen, P., industrial residue rich in selenium, 66
King's College, 128
Kingzett, C. T., activity of oxygen, 141
calcic hypochloride, 120
oxidation of terpenes, 120
ozone, 183
Kinnear, J. B., estimation of nitric nitrogen, 33
Kissling, R., chemistry of tobacco, 11
Klein, D., modification in the expression of the law of isomorphism, 243
Klepl, A., an unstable compound of phenol and carbonic acid, 149
two anhydrides of para-oxybenzoic acid, 173
Koch, L., manurial experiments at Plan, 150
Kœchlin, H., fixation of certain artificial colouring-matters by means of metallic mordants, 179
Kolbe, C., methacrylic acid, 124
H., an explanation, 208
antiseptic properties of carbonic acid, 283
Kollert, A., determination of sulphur in carboniferous substances, 13
Korschelt, O, Japanese soils, 187
Kosmann, M., roasting zinc blende, 58
Kraus, K., researches on the inner causes of growth, 123
Kraut, K., chloride of lime and chloride of lithia, 255
Krouchkoll, M., variation of friction produced by voltaic polarisation, 77
Kurbatow, A., and F. Beilstein, nature of the Caucasian petroleum, 160

LABORATORY instruction, chemical lectures, and classes, 137
notes, 187
Lamont, R., formation of ozone, 171
Landerer, Dr. X., communications from the East, 255
Landsberg, M., imides of bibasic acids, 280
Lange, M., analysis of sodium hydro-carbonate, 245
Laur, P., reduction of certain ores of silver, 47
Lauth, C., products of the distillation of beet-dregs, 185
Lava, chemical composition of, 23
Law, periodic, discovery of, 278

Lead, action of water on, 145, 170
and copper salts, behaviour of with soda lye, 120
detection of in presence of ammonium citrate, 184
in tin paper, 68
iodide, 290
plates, formation of secondary elements of, 159
poisoning case, Huddersfield, 38, 145
volumetric determination of, 48
zinc, and copper smelting works, injurious constituents of the smoke of, 208
Lebaigne, E., determination of sugars by polarised light, 291
Le Bon, G., properties of antiseptics, 269
two new antiseptics, 66
Le Chatelier and Mallard, MM., nature of the vibratory movements which accompany the propagation of flame in combustible gaseous mixtures, 184
Leclanché cell, 259
Lecoq de Boisbaudran, M., decomposition of gallium protochloride by water, 46
separation of gallium, 3, 69, 152, 165, 211
Ledieu, A., objections of a mechanical order to the theory of electricity, 207
Leeuw, M., sorghum tartaricum, 185
Lefort, J., and P. Thibault, influence of gum arabic in certain chemical reactions, 233
Leidie, curves of solubility in water of the varieties of tartaric acid, 57
Leplay, H., chemical studies on sugar beet, 254
studies on maize, 302
"Letts and Co.'s Diaries for 1883" (review), 254
Liebermann, C., and P. Jacobson, formation and constitution of naphtho-quinone, 209
reduction experiments in the anthraquinon series, 67
Light, polarised, determination of sugars, 291
velocity of of different colours, 288
"Light, a Course of Experimental Optics chiefly with the Lantern" (review), 112
Lighting, electric, by incandescence, 49, 59
Lightning conductors, 243
rods, 66
Lippmann, G., thermoscopic method for the determination of the Ohm, 207
Liquid compounds, researches on the specific volumes of, 197
Liquids, alcoholic, passage of through porous bodies, 254
reciprocal solutions of, 256
Lithia and lime, chlorides of, 255
Litmus-paper, certain arseniates neutral to, 122
Liveing, G. D., Address to Chemical Section of British Association, 97
and J. Dewar, origin of the hydrocarbon flame spectrum, 293
Loges, G., and A. Emmerling, dung of deep stalls, 123
London, South, School of Chemistry, 48
University, 126
water supply, 17, 107, 153, 191, 236, 297
Lophin, constitution of, 241
Louïse, L., action of anhydrous aluminium chloride upon acetone, 184
Louise, M. E., new hydrocarbide, 302
Ludwig, M., poisoning by arsenic compounds, 233
quantitative determination of usine, 24
Lucidine and quinoleine, researches on, 114
Lunge, G., calcic hypochlorite, 148
determination of sodium ferrocyanide in soda, 11
"Distillation of Coal-tar" (review), 157
Lupinine, behaviour of with dehydrating agents, 255
Lupin, poisonous action of, 233
Lupton, S. E., "Elementary Chemical Arithmetic" (review), 102

MACAGNO, J., and E. A. Grete, determination of carbon disulphide, 2
"Machine Design, Elements of" (review), 103
"Machines, Magneto- and Dynamo-electric" (review), 230
Maercker, M., potassium salts as manure for beetroot, 159
Magenta, orchil, and cudbear in wine, detection of, 123
Magnesia alum, 13
detection of in limestone, 11
Magnesic pyro-phosphate, estimation of phosphoric acid as, 213
"Magnetism" (review), 266
"Magnetism and Electricity, Elementary Lessons" (review), 278
"Magneto-Electric and Dynamo-Electric Machines" (review), 230
Magneto-electric machine, electromotive force of a, 10
Maize, studies on, 302
Malaria in the district of Rome, 93
Malic acid in mountain ash berries, 68
Mallard and Le Chatelier, MM., nature of vibratory movements which accompany the propagation of flame in combustible gaseous mixtures, 184
Mallet, J. W., determination of organic matter in potable water, 63, 72, 90, 101, 108
practical chemistry in the University of Virginia, 194, 204, 215
properties of pure metallic aluminum, 178
revision of the atomic weight of aluminum, 15, 27, 41
Maltose, dextrin, and dextrose, estimation of in amylose, 175
Maly, M., studies on caffeine and theobromine, 78
Manchester Literary and Philosophical Society, 288
Maneuvrier, G., and M. Jamin, electric arc in the vapour of carbon disulphide, 43
reaction current of the electric arc, 23
Manganese, appearance of on the surface of rocks, 122, 149
basic salts of, 57
Mannite, second anhydride of, 285
Manure, use of carnallite as, 149
Manures, artificial, influence of upon the physical conditions of the soil, 184
judicious use of, 24
Manurial experiments at Plan, 150
Maquenne and Dehérain, MM., reduction of nitrates in arable soils, 208, 232
Marcano, V., direct fermentation of starch, 254
fermentation of starch, 122
Marriott, W., and R. Abercromby, popular weather prognostics, 300
Martiny, B., Scherff's milk, 124
Massart, M., electrisation of the air, 280
Mason Science College, 132
Mathematical and Physical Science Section of the British Association, Address to, 95
Maumené, E. J., action of ammonia upon copper oxide, 103
existence of "azobihydre, 89
"Medicine, Retrospect of" (review), 21
Meldola, R., constitution of some bromine derivatives of naphthalene, 241
Melsens, M., lightning rods, 66
Mencki, M., admissibility of plastered wines, 58
Menke, A. E., and C. L. Jackson, certain substances from turmeric, 61, 70
Menschutkin, N., acetaniline, 207
determination of the isomerism of alcohols, 208
decomposition of tertiary amyle acetate by heat, 207
polyatomic alcohols, 160
Mercurial and hydrogen thermometers, comparison of, 254
thermometer, 280
thermometers, calibration of, 143
improvements in, 254
Mercuric compounds in benzol, 303
oxide, reciprocal displacements of acids combined with, 34
Metallic aluminium, pure, properties of, 178
mordants, fixation of certain artificial colouring matters by means of, 179
oxides, absorption of by plants, 224
thorium, 232
Metals, electrolytic precipitation of, 255
evaporation of in a vacuum, 77
precious, extraction of from ores, 121
separations of by the electrolytic method, 105
Metameric bodies, action of on Nicotiana longiflora, 271
Meteorological observation, use of kites for, 241
Society, 241, 300
Methacrylic acid, 124
Mexican amalgamation process, reactions of, 177
Meyer, L., atomic weight of glucinum, 159
compound of sulphurous anhydride and phenol, 149
evaporation without fusion, 160
V., and E. J. Constam, azaurolic acids, 255
Miasmatic fevers, 171
Miest and Blas, MM., electrometallurgic process, 93
extraction of precious metals from ores, 121
Mildew, 221
Milk and urine, new reaction of, 244
Scherff's, 124
Miller, A. K,, dihydroxy-benzoic acids and iodo-salicylic acids, 219
Mills, E. J., and J. Takamine, absorption of weak reagents by cotton, silk, and wool, 299
Mines, Royal School of, 150, 146
Miron and Bruneau, MM., reproduction of calcite and witherite, 77
Mixter, W. G., estimation of sulphur, 217
Mixtures, heat of solution of some, 103
Molecular compounds, constitution of, 275
Molybdate, ammonium and platinum chloride, recovery of, 243
Molybdates, silico, 269
Molybdic acid, hydrate of, 254
Mono-brom-pseudo-cumolic acid and dibrom-mesitylenic acid, 281
Mono-hydrate, dinitro-quinine, 93
Mono-hydrated sulphuric acid, volume-weight of, 291
Moritz, E. R., and A. Hartley, varying quantities of malt albumenoids extracted by waters of different types, 220
Morris, J., influence of mass upon chemical transformations, 172
Moser, J., strengthening telephonic currents, 251
Mouras, L., automatic "Vidangeuse" of, 244
Mourson, J., F. Schlagdenhauffen, and E. Heckel, researches on the globulariæ, 57
Mulhouse, Chemical School of, 35
Industrial Society of, 58, 232, 244, 291
Müller, C. L., certain derivatives of para- and ortho-nitro-cinnamic acid, 67
M., technical examination of glasses, 11
W., preparation of grape-sugar, 208
Muntz, A., and E. Aubin, atmospheric nitrification, 280
Musk, deodorisation of, 169
Myronic acid in oil-cake, 185

NANCY, trial field of, manurial experiments on the, 123
Naphtha, crude, 173
Naphthalene, bromine derivatives of, 241
Naphthol, action of chloroform upon, 47
Naphthols, reactive power of, 160
Naphtho-quinone, formation and constitution of, 209
Neitzki, R., Biebrich scarlet, 160
Nencki, M., basic products of putrefaction, 208
and N. Sieber, physiological oxidation, 208
Nesbit, A. A., detection of chloride of lime in water, 43
Nessler, J., proportion of sulphuric acid in red wines, 209
and M. Barth, analysis of wine, 11
Nesslerising, tube-stand for, 298
Neusser, E., colouring-matters of urines, 93
Nevile, R. H. C., and A. Winther, orcin, 220
Newcastle Chemical Society, 251, 261, 275
Address to, 253, 261, 275
Newlands, J. A. R., discovery of the periodic law, 278
Nickel chloride, action of sulphuretted hydrogen upon, 40
sulphate, action of heat upon a solution of, 11
Nicotiana longiflora, action of metameric bodies on, 271
Nietzki, R., quinones and hydroquinones, 269
Nilson, L. F., metallic thorium and atomic weight, 232
Nitrate, diazo-benzol, 35
of tin, 208
Nitrates, currents produced by, 280
fermentation of, 207
reduction of in arable soil, 208, 232
Nitric acid and ammonia in the glaciers of the Alps, 302
and nitrous acids, determination of in urine, 24
nitrogen, estimation of, 33

Nitrites, determination of, 1
Nitro-alizarine, new method of preparing, 47
Nitro-benzol and sulphur, new reagent for, 92
Nitro-benzyl-cyanide, diazo-derivatives of, 300
Nitrogen, absolute, determination of, 39
estimation of in coal and coke, 299
gaseous, liberation of in putrefaction, 159
sulphide, 35
Nitrogenised matters of urine, determination of, 92
Nitrogenous colloids, 196
Nitrous acid, action of upon anethol, 160
Noelting, E., derivatives of rosaniline, 35
and R. Bourcart, action of sulphuric acid upon proto-catechuic acid, 36
Nymphaceæ, chemistry of, 268

OBITUARY, B. J. Grosjean, F.C.S., 76
Prof. W. Stanley Jevons, F.R.S., 76
the late Professor Wœhler, 183
Odling, W., W. Crookes, and C. M. Tidy, London water supply, 17, 107, 153, 191, 236, 297
Œnanthol, condensation-products of, 273, 299
Ogston, F., detection of chloral hydrate, 13
Ohm, determination of the, 207
Oil-cake, myronic acid in, 185
Oliver, L., and A. Etard, reduction of sulphates by living beings, 254
Orange-red, black appearing, 303
Orchil, cudbear, and magenta, detection of in wine, 123
Orcin, 220
Orcine, new isomer of, 36
Ore of selenium, treatment of, 60
Ores, errors in determining iron in, 40
extraction of precious metals from, 121
Organic bases in commercial amylic alcohol, 268
compounds, synthesis of several, 25
matter, determination of in potable water, 63, 72, 90, 101, 108
of traces of in potable water, 23
Osmides, iridium, reproduction of, 280
Osmond, F., and G. Witz, introduction into the arts of vanadium, 47
vanadium, 196
Osmose water, manurial results with, 123
Ostwald, W., preparation and correction of burettes, 149
Otto, J. C., preparation of grape-sugar, 208
Oxford University, 127
Oxidation and phosphorescence of phosphorus, 92
of terpenes, 120
physiological, 208
Oxides, certain, action of potassium bimolybdate upon, 35
metallic, absorption of by plants, 224
Oxygen, activity of, 141
and carbonic oxide, explosion of, 151
preparation of, 221
Oxygenated water, electrolysis of, 46
Ozokerite, purification of, 243
Ozone, 12, 183, 268
formation of, 171

PALLADIOUS compounds, principal, formation-heats of the, 113
Palmieri, M., reducing action of glycerin, 245
Paper, writing and printing, incombustible, 267
Para-oxy-benzoic acid, two anhydrides of, 173
Parmentier, F., action of potassium bimolybdate upon certain oxides, 35
hydrate of molybdic acid, 254
silico-molybdates, 269, 303
Parasites, destruction of the germs of, 57
"Patent Law, Hand-book of of all Countries" (review), 103
Patents, notices of, 267
Pegna, E., dissociation of copper sulphate, 123
Pemberton, H., new method of determining phosphoric acid, 4
"Pennsylvania Pharmaceutical Association" (review), 266
Peptones, influence of on the diastatic action of saliva, 180, 189
Periodic law, discovery of, 278
Perkin, W. H., condensation-products of œnanthol, 273, 299
diazo-derivatives of nitro-benzyl-cyanide, 300
Permanganate, potassium, action of upon venoms, virus, and zymotic diseases, 114
Peroxide of hydrogen, 221
Perry and Ayrton, Profs., resistance of the voltaic arc, 288
Petroleum and picene, 47
Caucasian, nature of the, 160
determination of the flashing-point of, 297
oil, novel transformation of for lighting purposes, 161
Pettenkoffer's reaction, modification of for bile acids, 119
Pfaundler, M., curious explosions, 281
Phenol and carbonic acid, unstable compound of, 149
and sulphurous anhydride, compound of, 149
detection of in creosote, 244
in urine, 281
volumetric determination of, 196
Phenological observations for the year 1882, 300
Philip, A., action of water on lead, 170
Phillips, F. C., absorption of metallic oxides by plants, 224
Phipson, T. L., colouring-matter and alkaloid contained in Agaricus ruber, 199
Phosphate, tricalcic, transforming into the chlorinised compounds of phosphorus, 302
Phosphates, decomposition of by potassium sulphate, 280
natural, manurial experiments on the action of, 125
reverted, determination of, 18, 31
Phosphoric acid, agricultural value of the different combinations of, 185
estimation of as magnesic pyro-phosphate, 213
in the arable soils of the north, 24
new method of determining, 4
Phosphorus, black, 155
in iron and steel, 23
iodides, equivalent of the, 113
penta-chloride, action of upon the amides of acids, 255
phosphorescence and oxidation of, 92
Phthalic acid, urea, and thio-urea, derivatives of, 185
with the phenols, compounds of, 78
Physical and Mathematical Science Section of the British Association, address, 95
properties of the soil in a dense and in a loose state, 125
Science, College of, 133
Society, 230, 251, 288
Physics, historical notes on, 230
"Physics, Modern, Concepts and Theories of" (review), 156
Picene, 160
Pichard, M., detection of magnesia in limestone, 11
Pickering, S., testing for barium or sulphuric acid, 223
constitution of molecular compounds, 275
Pictet, A., researches on quinoleine and lucidine, 114
Pig-iron, estimation of sulphur in, 236
Pillitz, W., studies on argentous oxide, 11
Pinard, G., discovery of coal in Algiers, 232
Piutti, A., urea and thio-urea derivatives of phthalic acid, 185
Planté, G., formation of secondary elements of lead plates, 159
Plants, absorption of metallic oxides by, 224
Platinum chloride and ammonium molybdate, recovery of, 243
metals, explosive alloys of, 10
Potassium bimolybdate, action of upon cer ain oxides, 35
Polarisation, oscillations of the plane of, 10
voltaic, variation of friction produced by, 77
Polarised light, determination of sugars by, 291
Poly-atomic alcohols, 160
Portele, C., and M. Van Babo, solubility of potassium bi-tartrate, 233
Post, J., recovery of platinum chloride and ammonium molybdate, 243
Potassa in manures, determination of, 212
volumetric determination of, 233
Potassium bi-tartrate, solubility of, 233
carbonate, preparation of from potassium chloride, 267
ferrous oxalate, reducing action of, 12
permanganate, action of upon venoms, 114
salts as manure for beet-root, 159
Preston, T. A., phenological observations for the year 1882, 300
Proctor, B. S., inaugural address, 253, 261, 275
Proudlock, A., a warning, 183
Prunier, H., purification of zinc sulphate, 68
Prussian blue, solubility of in Turnbull's blue, 12
Pump, vacuum, 245
Puscher, C., preparation of precipitated tin, 303
Putrefaction, basic products of, 208
Pyridic bases derived from brucine, 114
Pyrological notes, 179, 200, 223, 248, 273, 283

"QUANTITATIVE Analysis, Student's Guide in" (review), 112
Quantitative determination of the albumenoids, 185
Quartz, electric deformations of, 260
Queen's College, Belfast, 137
Cork, 137
Quinoleine and lucidine, researches on, 114
and pyridine, action of bromine upon, 57
Quinones and hydro-quinones, 269

RAINBOWS, production of, 251
Rainfall, daily course of, 184
Ramsey, W., specific heats, 269
Raoult, F. M., general law of the congelation of solvents, 302
law of the congelation of the solutions of neutral substances in benzol, 77
Rattlesnake poison, 165
Rayleigh, M., address to the Mathematical Section of the British Association, 95
Reed, L., electricity and comets, 207
Refrigerator and ice-machine patent vacuum pump, 192
Reinke, J., easily oxidisable compounds of the vegetable body, 209
Rémont, A., determination of salicylic acid, 243
Renard, A., products of the distillation of resin, 23, 104
products of the distillation of colophonium, 66
Renni, F., dinitro-quinine monohydrate, 93
Resin, products of the distillation of, 23, 104
Reynolds, J. E., action of the metameric bodies on Nicotiana longiflora, 271
Rhodium ammoniacal compounds, 67
Riban, J., method of transforming tricalcic phosphate into the chlorinised compounds of phosphorus, 302
Riccardi, L., chemical composition of lava, 23
Richet, C., new reaction of urine and milk, 244
poisonous power of the alkaline chlorides, 23
Riffard, E., chemical manures applicable to the sugar-cane, 24
Ritthausen, H., composition of the albumenoids of hemp-seeds, 303
Robin, A., detection of sugar in the urine, 78
new method of recognising the alkaloids in their salts, 243
Rocholl, H., estimation of sulphur in pig-iron, 236
Röhmann, F., determination of nitric and nitrous acids in urine, 24
Romanis, R., analyses of tobacco ash, 248
analysis of potash made from Kyathourg bamboo, 51
laboratory notes, 187
Rome, malaria in the district of, 93
Rosaniline, derivatives of, 35
Rosanilines, conditions of the formation of the, 104
Rosenstiehl, A., and M. Gerber, conditions of the formation of the rosanilines, 104
Ross, W. A., cause of the colour of certain precious stones, 33
chemistry and courtesy in Germany, 112, 148
pyrological notes, 179, 200, 223, 248, 273, 283
Rousseau, G., action of chloroform upon naphthol, 47
Rovera, S., detection of lead in presence of ammonium citrate, 184
Royal Agricultural College, Cirencester, 132

Royal College of Science for Ireland, 137
Institution, 36
of Great Britain, 230, 275
School of Forestry at Aschaffenburg, chemical laboratory of, 185
of Mines, 130, 146
Society, 261
"Royal Society of New South Wales, Journal and Proceedings of" (review), 182
Rubidium and cæsium, 249
Rüdorff, F., albo-carbon burners,
Rupert's drops, 283
Russian Chemical Society, 78, 114, 255, 256, 292

SABATIER, P., sulphur compounds of silicium, 256
Saccharines, 48
Salet, G., amplitude of telephonic vibrations, 77
Salicylic acid, determination of, 243
Salomon, F., composition of starch, 67
Saliva, influence of peptones on the diastatic action of, 180, 189
Salt in beer, 48
Salts, decomposition of, 10
double, formed by fusion, characters and functions of the, 10
Sand-bath, substitute for, 281
Santa, P., typhoid fever at Paris, 159
Schaffner-Helbig process, 267
Scherff's milk, 124
Schertel, A., volume weight of mono-hydrated sulphuric acid, 291
Schlagdenhauffen, F., E. Heckel, and J. Mourson, researches on the Globulariæ, 57
"School of Mines, Ballarat" (review), 242
Schott, E. A., and A. Wachtel, new substitutes for bone-black, 124
Schulze, E., cholesterines, 149
H., arsenic sulphide in aqueous solution, 124
Schützenberger, P., and A. Colson, silicium, 35
Science, American Association for the Advancement of, 115, 167
College, Mason, 132
Normal School of, 130
Royal College of, for Ireland, 137
Scientific chemist, status of, 48
work, annual record of published, 55
Secondary battery, 183
Seeds, testing the germinating power of, 209
Selenium, industrial residue rich in, 66
treatment of an ore of, 60
Senderens and Filhol, MM., certain arseniates neutral to litmus-paper, 122
Satterberg, M. C., researches on rubidium and cæsium, 249
Sewage process, new, 268
treatment, 197
Sexton, A. H., determination of arsenic in copper, 77
Shenstone, W. A., brucine, 300
Siber, N., and M. Nencki, physiological oxidation, 208
Siemens, C. W., Address to British Association, 79
and A. K Huntington, electric furnace, 163
Siemens Gold Medal and Prize, 104
Silber, P. G., action of hydrochloric acid gas at elevated temperatures upon the ultramarines of the series rich in silica, 161
Silicium, 35
sulphur compounds of, 256
Silico-molybdates, 269, 303
Silk, cotton, and wool, absorption of weak reagents by, 299
Silver, reduction of certain ores of, 47
separation of from lead, 13
Simon, S. E., new method of preparing nitro-alizarine, 47
Slater, J. W., "Manual of Colours and Dye-wares" (review), 9
Smith, E. F., determination of boracic acid, 286
R. A., development of living germs in water, 289
Society, Chemical, 219, 239, 273, 299
Industrial, of Mulhouse, 58, 232, 244, 291
Manchester Literary and Philosophical, 288
Meteorological, 241, 300
Newcastle Chemical, 251, 261, 275
of Arts, 245
of Chemical Industry, 56
Physical, 230, 251, 288
Royal, 261
Russian Chemical, 78, 114, 255, 256, 292
"Society, Royal, of New South Wales, Journal and Proceedings of" (review), 182
Soda, caustic, estimation of, 197
Soda-lye, behaviour of copper and lead salts with, 120
Sodium ferrocyanide, determination of in soda, 11
hydro-carbonate, analysis of, 245
tungstate as a reagent for baryta, 12
Soil, influence of artificial manures upon the physical conditions of, 184
physical properties of in a dense and in a loose state, 125
Soils and building materials, permeability of, 11
Solvents, general law of the congelation of, 302
Sorghum tartaricum, 185
Soward, A. W., new process for insulating electric wires, 149
Specific heats, 269
volumes of liquid compounds, researches on, 197
Spectral rays of hydrogen, expansion of, 149
Spectra of the non-metals, influence of temperature on, 171
Spectrum, hydrocarbon flame, origin of the, 293
Spring, W., isomorphism, 93
Stallo, H., and F. W. Clarke constitution of the antimony tartrates, 160
J. B., "Concepts and Theories of Modern Physics" (review), 156
Stannic oxide, precipitation of, 286
Stapleton, J., preparation of the alkaline potassium permanganate solution used for water analysis, 284
Starch, 67
direct fermentation of, 254
fermentation of, 122
Steel and iron, estimation of, 272
sulphur in, 199
coercitive force of rendered permanent by compression, 184
Stoddard, J. T., determination of the flashing-point of petroleum, 297
Stokes, W., "Address in Surgery" (review), 206
Strontianite, detection of, 268
Students, address to, 125
Stutzer, M., quantitative determination of the albumenoids, 185
articles of diet for invalids and children, 209
Succinine, 123
Sugar analysis, 22, 45, 113
beet, chemical studies on, 254
behaviour of arsenic acid with, 13
cane, chemical manures applicable to the, 24
detection of glucose in, 24
in the urine, 78
Sugars, detection of by polarised light, 291
Sulphate, aluminium, from bauxite, 256
of copper, dissociation of, 123
of zinc, purification of, 68
potassium, decomposition of phosphates by, 280
Sulphates, ferric, new, 36
reduction of by living beings, 254
Sulphide, arsenic, in aqueous solution, 124
hydrated hydrogen, 66
nitrogen, 35
Sulphites, cuprous, derivatives of the, 66
isomerism, of, 47
Sulphur and nitro-benzol, new reagent for, 92
compounds of silicium, 256
determination of in carboniferous substances, 13
estimation of, 217
in iron and steel, 199
in pig-iron, 236
separation from its gangue, 254
Sulphuretted hydrogen, action of, 17
upon nickel chloride, action of, 40
Sulphuric acid, action of upon proto-catechuic acid, 36
mono-hydrated, volume-weight of, 291
or barium, testing for, 223
proportion of in red wines, 209
volumetric estimation of, 221
Sulphurous anhydride and phephenol, compound of, 149
"Surgery, Address in" (review), 206
Süssenguth, H., mono-brom-pseudo-cumolic acid and dibrom-mesitylenic acid, 281
Swan, J. W., electric lighting by incandescence, 49

TAKAMINE, J., and E. J. Mills, absorption of weak reagents by cotton, silk, and wool, 299
Tallow in Paris, commercial examination of, 11
Tannate of soda, 257
Tannin, extracting, 68
Tartaric acid, varieties of, researches on the curves of solubility in water of the, 57
Taylor, I., Rupert's drops, 283
Telegraphic line, transmission of work to a distance by means of, 207
Telephonic currents, strengthening of, 251
vibrations, amplitude of, 77
Telluric rays, 280
preparation and quantitative determination of, 124
Terpenes, oxidation of, 120
Tertiary amyle acetate, decomposition of, 207
Thénard, P., black phosphorus, 155
Theo-bromine and caffeine, 78
Thermal water, Buxton, new analyses of, 201
Thermic constants, law of of substitution, 159
data, numerical relations between, 113, 149, 161
Thermometers, an improvement in, 245
mercurial, calibration of, 143
and hydrogen, comparison of the, 254
Thermoscopic method for the determination of the ohm, 207
Thibault, P., and J. Lefort, influence of gum arabic on certain chemical reactions, 233
Thomas, E. G. P., and O. N. Witt, researches on the indu-line group, 300
Thompson, L., useful application of electricity, 301
S. P., "Elementary Lessons in Electricity and Magnetism" (review), 278
historical notes on physics, 230
W. P., "Hand-book of Patent Law of all Countries" (review), 103
Thomsen, J., constitution of benzol, 160
Thorium, metallic, 232
Thresh, J. C., new analyses of the Buxton thermal water, 201
orchard alum spring, 226
Tichborne, C. R. C., determining the hardness of water, 235
estimating ammonia in potable waters, 247
Tidy, C. M., W. Crookes, and W. Odling, London water supply, 17, 107, 153, 191, 236, 297
Tilden, W. A., a warning, 207
hydrocarbons, 120
Tin and antimony, determination and separation of, 172
separation of, 268
bisulphide and biselenide, certain compounds of, 207
nitrate of, 208
paper, lead in, 68
precipitated, preparation of, 303
Tissues and yarns, detecting dyes on, 211, 250, 260
Tobacco ash, analyses of, 248
chemistry of, 11
Tœnnies, P., action of nitrous acid upon anethol, 166
"Tokio Daigaku" (review), 207
Tommasi, D., action of aluminium upon cupric chloride, 62
chemical work produced by the battery, 77
decomposition of copper acetate, 292
dissociation of copper sulphate, 123
electrolysis of hydrochloric acid, 208
isomeric modification of a ferric hydrate, 93
law of the thermic constants of substitution, 159
nascent hydrogen, 256
new accumulator with carbon electrodes, 303
numerical relations between thermic data, 113, 161
researches on the ferric hydrates, 256
synthesis of several organic compounds, 25
use of zinc-coke elements in electrolysis, 34
Toms, M., chemistry of hay and "ensilage," 275
Trécul, A., instance of black appearing orange-red, 303
Treglohan, T. P., "Magnetism" (review), 266
Trève, M., process for avoiding explosions, 172
Tricalcic phosphate, transforming into the chlorinised compounds of phosphorus, 302

Troost, L., determination of vapour densities, 47
equivalent of the phosphorus iodides, 113
Tscherniac, J., adulteration of barium sulpho cyanide, 268
Tube-stand for Nesslerising, 298
Tucci, M., malaria in the district of Rome, 93
Tucker, J. H., sugar analysis, 113
Tungstate, sodium, as a reagent for baryta, 12
Tungsten, separation of from antimony, 13
Turmeric, certain substances from, 61, 70
Typhoid fever at Paris, 159

ULTRAMARINE, 114

Universities and Colleges, 126
University College, 129
Bristol, 13
Liverpool, 133
Nottingham, 135
of Wales, 131
Laboratory of Würzburg, 68
of Cambridge, 128
of Durham, 133
of Edinburgh, 136
of London, 126
of Oxford, 127
of Virginia, practical chemistry in the, 194, 204, 215
Unwin, W. C., "Elements of Machine Design" (review), 103
Uranates by the dry way, production of certain crystalline, 290
Uranium, 172
Urea, test for, 242
and thio-urea derivatives of phthalic acid, 185
Urine and milk, new reaction of, 244
detection of phenol in, 281
of sugar in, 78
determination of nitric and nitrous acids in, 24
of nitrogenised matters of, 92
quantitative determination of, 24
Urines, colouring matters of, 93

VACUUM pump, 245
refrigerator and ice-machine, patent, 192
Vanadium, 196
green, 268
introduction into the arts of, 47
Van Bemmelen, J. M., hydrates of glucinum, 291
Van der Berghe, J., presence and determination of copper in bread, 92
Vanderpol, M., cause of offensive odours too often overlooked, 36
Vanilline, artificial, 243
Van Monckhoven, D., expansion of the spectral rays of hydrogen, 149
influence of temperature on the spectra of the non-metals, 171
Vapour-densities, determination of, 47
Vegetable body, easily oxidisable compounds of, 209
fibres, analysis of certain, 240
Venoms, action of potassium permanganate upon, 114
"Vidangeuse," automatic, 244
Vieille, M., limits of nitrification of cellulose, 66
and M. Berthelot, diazo-benzol nitrate, 35
period of variable condition which precedes detonation, 103
Ville, J., and W. Crookes, "Artificial Manures" (review), 168
Vineyards, manuring, 303
Vinter, A., "Chemical Calculations" (review), 266
Virginia, practical chemistry in the University of, 194, 204, 215
Vitali, S., detection of chloroform, 243
Voltaic arc, resistance of, 288
Volta prize, 290
Volckxsom, E. W., "Catechism of Modern Elementary Chemistry" (review), 21
Volumetric determination of copper, iron, and antimony, 285
of ferrous oxide, 12
of lead, 48
of the alkaline earthy carbonates contained in waters, 302
Von Gerichten, E., cotarnine, 63
Vulpian, M., action of potassium permanganate upon venoms, 114

WACHTEL, A., and E. A. H. Schott, new substitutes for bone-black, 124
Wagner, P., manuring vineyards, 303
Wales, Univessity College of 131
Wallach, O., action of phosphorus penta-chloride upon the amides of acids, 255
Walter, J., petroleum and picene, 47
Water, action of on lead, 145, 170
analysis, 227, 237, 267
alkaline potassium permanganate solution used for, 284
Water, Buxton thermal, new analyses, of the, 201
crystalline, of calcium butyrate, 78
decompositon of gallium protochloride by, 46
detection of chloride of lime in, 43
determining the hardness of, 235
development of living germs in, 289
drinking, hygienic signification of, 149
oxygenated, electrolysis of, 46
potable, determination of organic matter in, 63, 72, 90, 101, 108
of traces of organic matter in, 23
supply, London, 17, 107, 153, 191, 236, 297
"Water Works Statistics" (review), 76
Waters of different types, varying quantities of malt albumenoids, extracted by, 220
potable, estimating ammonia in, 247
volumetric determination of alkaline earthy carbonates in, 302
waste, of manufactories, purification of, 24
Watson, D., determination of arsenic in copper, 46
G., new catalytic reaction, 9
Weather prognostics, popular, 300
Weller, A., determination and separation of antimony and tin, 172
Weber, R., nitrate of tin, 208
Webster, C. S., analysis of certain vegetable fibres, 240
Weigelt, C., determination of ash in flour, 12
Weil, F., electro-chemical deposits of various colours, 290
Wheat, means of lowering the production cost of, 36
White, J. F., and C. L. Jackson, substituted benzol compounds, 44, 52
Wiesbaden, chemical laboratory of, 114
Wiesenthal, W., deoderisation of musk, 169
Wilbur, F. A., and P. T. Austen, tube-stand for Nesslerising, 298
Wilot, E., agricultural value of the different combinations of phosphoric acid, 185
Wiley, H. W., estimation of dextrose, maltose, and dextrine in amylose, 175
a correction, 267
Wine, analysis of, 11
detection of magenta, orchil, and cudbear in, 123
Wines, composition of by Petiot's process, 104
Wines, determination of astringent matters in, 77
plastered, admissibility of, 58
plastered and deplastered, 104
Winther, A., and R. H. C. Nevile, orcin, 220
Witherite and calcite, reproduction of, 77
Witt, O. R., and E. G. P. Thomas, researches on the induline group, 300
Wittgen, B., and E. Cuno, preparation of potassium carbonate from potassium chloride, 267
Witz, G., and Osmond, F., introduction into the arts of vanadium, 47
vanadium, 196
Wœhler, the late Professor, 183
Wollny, E., influence of artificial manures upon the physical conditions of the soil, 184
physical properties of the soil in a dense and in a loose state, 125
Wood, Indian, analyses of, 187
Woodward, C. J., "Arithmetical Chemistry" (review), 231
Wool, cotton, and silk, absorption of weak reagents by, 299
Wright, L., "Light, a Course of Experimental Optics, chiefly with the Lantern" (review), 112
Wrigley, G., tannate of soda, 257
Writing and printing papers, incombustible, 267
Wroblewski, S., influence of the quantity of gas dissolved in a liquid upon its surface-tension, 113
surface-tension contact with carbonic acid, 122
Würsburg, Laboratory of, 68
Wüsthoff and Jehn, MM., detection of strontianite, 268

YARNS and tissues, detecting dyes on, 211, 250, 260
Yorkshire College, Leeds, 132
"Yorkshire College, Leeds" (review), 231
"Young" Chair of Technical Chemistry, 136

ZELLER, A., separation of antimony and tin, 268
Zimmermann, C., uranium, 172
volumetric determination of ferrous oxide, 12
Zinc blende, roasting, 58
coke elements, use of in electrolysis, 10, 34
copper, and lead smelting works, injurious constituents of the smoke of, 208
determination of, 220, 221
explosive alloys of, 10
sulphate, purification of, 68

END OF VOLUME XLVI.

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